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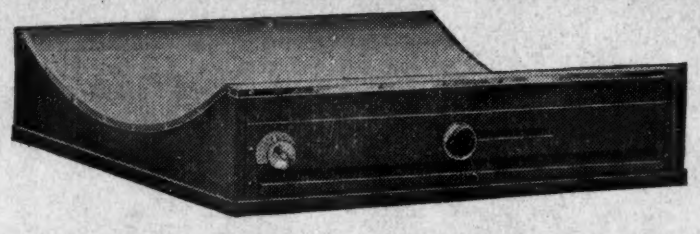

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—Journal A. M. A., January 1, 1921, page 33.

"WHEN we consider the use of mixed vaccines, we find at once more valuable and more enthusiastic reports as regards their preventative value. * * * * *

"Mixed vaccines have been used, not only preceding exposure to influenza, but also during the course of the disease in the hope of preventing its complications. There is a steadily growing body of information, * * * * * that would seem to indicate that a mixed vaccine containing streptococcus and pneumococcus in addition to influenza bacilli will notably decrease the pneumonic complications of influenza." * * * * *

"Cary, and Roberts and Cary, have not only prevented the occurrence of pneumonia by the use of a mixed vaccine, but have actually produced a rapid cure of pneumonia during its course." * * * * * Journal A. M. A., January 22, 1921.

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Fig. 5. Enucleation of lateral lobes, completed with finger, the tractor being carried downward.

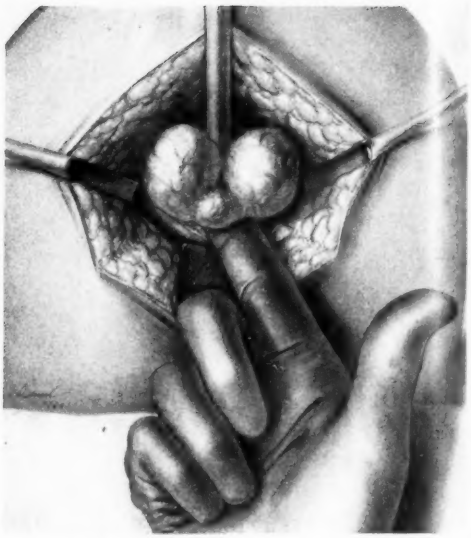

Fig. 7. The middle lobe attached to the two lateral lobes, already freed, is being separated from the sphincter and vesical mucosa, and enucleated from behind forward.

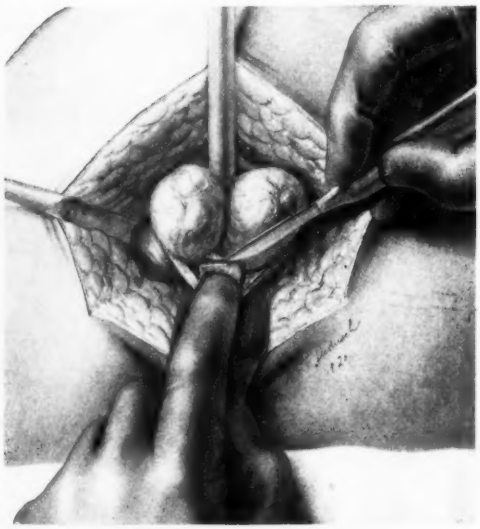

Fig. 6. With tractor held vertically, beak directed downward, the lateral lobes having been freed, the mucous membrane in front of the middle lobe is being divided transversely with scalpel. Ejaculatory ducts covered by index finger, which pushes them backward.

Fig. 8. The tractor has been removed and the index finger of the left hand introduced through the vesical orifice into the bladder to investigate the median portion. The subtrigonal lobule has been discovered, and is being separated from the sphincter.

Prostatectomy—Pre-Operative, Operative, and Postoperative Treatment.—Hugh Hampton Young.

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PROSTATECTOMY—PRE-OPERATIVE, OPERATIVE, AND POSTOPERATIVE TREATMENT[1]

BY HUGH HAMPTON YOUNG, M.D., F.A.C.S., BALTIMORE
From the James Buchanan Brady Urological Institute, Johns Hopkins Hospital, Baltimore, Maryland

PRE-OPERATIVE TREATMENT

IT is in the pre-operative treatment that most has been accomplished in reducing the mortality of prostatectomy and making the operation safe and practical for all cases. The one most important thing in the form of treatment is preliminary drainage. My attention was first called to the marvelous effects of drainage in a case of prostatic hypertrophy that was admitted to the Johns Hopkins Hospital in 1898 with a hugely distended bladder and in deep uræmic coma. Catheterization was attempted without success, and suprapubic drainage was accordingly carried out, and I witnessed for the first time the amazing disappearance of coma and restoration to apparently normal condition as a result of drainage. One month later I carried out my first prostatectomy suprapubically, removing a huge prostate successfully. The patient had an excellent convalescence.[2] Following this case, whenever patients presented themselves with evidence of renal impairment and particularly if uræmia was present, drainage either by intermittent or continuous catheter or by suprapubic drainage was carried out with the result that several desperately ill patients were operated upon successfully after a period of from 4 to 6 weeks' preparatory treatment.

[2] Tr. Virginia M. Soc., 1899.

The next important step in preparatory treatment was the use of large quantities of water, and this point in technique was adopted as a result of the following case which I reported in the *Maryland Medical Journal* in 1898.

A boy with a large appendiceal abscess was operated on by Dr. Halsted, and on the following day grew rapidly weaker, "temperature rose to 105.8,° the pulse to 156, but there were no signs of general peritonitis, and the condition was one of general septicæmia. Being in charge of the case in the country and having the responsibility, I realized that drastic measures were necessary and decided to try the effect of venesection and transfusion to wash out the poison in the blood. . . . Accordingly at 7 p.m., using cocaine anæsthesia, I opened the right basilic vein and allowed the blood to flow out, but the blood pressure was very weak and we could obtain only about 2½ ounces. I then injected normal salt solution, 1300 cubic centimeters being inserted. During this procedure the pulse steadily improved, and at the end had fallen from 160 to 130, and the volume had become fairly strong. His temperature fell from 105.8° to 104°, and his general condition was much bettered.

"This improvement was very decided for an hour after the transfusion, the nausea ceased, and he slept for a short while, but very soon the pulse became more rapid, and at 3 a.m. was 146 and quite weak. The patient was restless and the temperature was 104°. It was very evident that while the transfusion had been very beneficial it had not been sufficient, although he had received 700 cubic centimeters subcutaneously and 1300 cubic centimeters intravenously. Preparations were then made for another transfusion and at 6:45 a.m. it was begun. Twenty-

[1] Read before the Clinical Congress of American College of Surgeons, Boston, October 23–26, 1922.

five hundred cubic centimeters of salt solution were introduced into the vein during a period of 1 hour and 25 minutes, and had the effect of completely washing out the blood infection. The temperature and pulse dropped to almost normal, and after that there was never any concern about the boy's welfare."

My conclusions were that this case demonstrated the wonderful possibilities of saline solutions, but that it was certain that a small amount would be utterly useless in many cases. The curative effect was probably due to the dilution of the poison, and its rapid elimination by the excretory organs, and I recommended the method in acute uræmia, eclampsia, coma, operative shock, etc. It may be noted that the patient received 700 cubic centimeters subcutaneously and 3800 cubic centimeters intravenously during a period of 14 hours. Thereafter I did not hesitate to use water in large amounts in all cases of impaired renal function or uræmia and sepsis.

One of the most striking examples of results of this method of treatment was that of the following:

A man, No. 144, aged 76, who was brought into the hospital in uræmic coma, Cheyne-Stokes respiration, and a distended bladder from which a catheter withdrew 580 cubic centimeters of residual urine of very foul character filled with pus, bacteria, albumin, and casts. This patient was treated by intermittent catheterization, blood letting, transfusions and infusions. He was bled twice, 75 and 400 cubic centimeters being removed and salt infusions were given beneath the breast and transfusions (1000 cubic centimeters in the veins) and repeated several times over a course of 3 to 4 days. In 2 days the patient, who was apparently moribund became conscious and was soon able to talk coherently. At the end of a week the uræmic symptoms were entirely gone, and after that the patient's improvement was steady so that at the end of 6 weeks operation was performed successfully to remove the prostatic obstruction and the patient lived several years afterward.

The results obtained in these 3 striking cases furnished the groundwork for the method of preparatory treatment which has since been carried out.

In 1902, after having tried suprapubic prostatectomy and the Bottini operation, both with unsatisfactory results and with fairly high mortality, I brought out my prostatic tractor and developed the operation of "conservative perineal prostatectomy" which, with slight modifications, has been followed up to the present time, and as it is just 20 years today since the first of these operations was performed, it has seemed a propitious time to present a very careful analytical study of the 1049 cases which I have personally operated upon, particularly in regard to the preparatory treatment which was used and the results which have been obtained.

For purpose of comparison it seems well to refer to the first analytical study of 145 cases which was published in vol. xiv of the *Johns Hopkins Hospital Reports* in 1906. The mortality then was 4.8 per cent. Forty-one had been put on preparatory treatment consisting of catheter drainage and forced water by mouth or infusion or occasional intravenous transfusion and by rectum. Of these 32 cases were treated by frequent intermittent catheterization two to four times a day, and 9 by continuous catheter drainage for periods of from one to four weeks. The functional improvement of the kidneys was determined by the increase in the elimination of urea and the specific gravity of the urine as well as by the general condition of the patient. I tried the phloridzin test of renal function and also the freezing point test, but found both unsatisfactory and of very little assistance in determining the improvement of the kidneys in these cases.

In 1909 following work by Abel, in which the selective action of the kidney in the elimination of phenolsulphonephthalein had been demonstrated, Rountree presented an experiment upon a dog before the Inter-Urban Surgical Society. After bringing one ureter out through the skin of the abdomen so that the urine could be separately studied, he injected the renal artery with chemicals to produce a nephritis. Subsequently an intramuscular injection of phenolsulphonephthalein was made. With a catheter in the bladder collecting the urine from the normal kidney and the other ureter draining externally, a comparison of the separated urine showed that the phenolsulphonephthalein was more abundantly secreted from the supposedly diseased kidney which had been injected with chemical irritants.

TABLE I.—PHTHALEIN TESTS ON ADMISSION AND AGAIN BEFORE OPERATION IN SOME CASES

Phthalein test on admission	Phthalein test just before operation													
	Test not repeated	0–4	5–9	10–14	15–19	20–29	30–39	40–49	50–59	60–69	70–79	80–89	90–99	Total
?	..	..	..	..	..	1	1	2	3	4	2	..	1	..
0– 4%	..	..	..	1	..	2	..	..	..	1	..	..	..	4
5– 9%	..	..	..	1	..	2	1	..	..	..	..	..	..	4
10–14%	1	..	..	1	1	2	..	4	1	..	..	..	..	10
15–19%	1	..	..	..	..	2	1	1	1	..	..	..	..	6
20–29%	6	..	..	..	..	2	5	10	11	2	..	..	..	36
30–39%	15	..	..	..	..	1	7	14	20	9	4	..	..	70
40–49%	60	..	..	..	..	1	4	11	21	14	1	..	..	112
50–59%	95	..	..	..	..	2	1	6	20	18	5	..	..	147
60–69%	92	..	..	..	..	..	..	2	8	18	5	..	..	125
70–79%	16	..	..	..	..	..	..	..	..	1	1	1	..	19
80–89%	2	..	..	..	..	..	..	..	..	..	1	..	..	3
90–99%	..	..	..	..	..	..	..	..	..	..	..	1	..	1
Totals	283	..	..	3	1	15	20	50	85	67	19	2	1	..
Phthalein tests not repeated	..	..	..	1	1	6	15	60	95	92	16	2	..	..
Total phthalein at operation	..	..	..	4	2	21	35	110	180	159	35	4	1	551
Percentage	..	..	..	.73	.35	3.8	6.3	20	32.3	28.8	6.3	.73	.18	

The deductions drawn from this case were that phenolsulphonephthalein was more abundantly secreted by a diseased kidney, and as I had in my wards a human case practically identical with that of the dog, in which one ureter was draining externally, I suggested that the test be tried upon this patient. The results obtained when finally analyzed showed that the drug was in realty eliminated in large quantity by the healthy kidney and not by the diseased as supposed. (Probably a hyperæmia had been produced and not a real nephritis by the injection into the renal artery.) During the course of the next few months our cases were subjected to the phenolsulphonephthalein test in my wards, and Geraghty and Rountree presented their splendid paper on this subject which standardized the test and has been corroborated by much research and hundreds of scientific papers throughout the world.

After this the drug was tried out in cases of prostatic hypertrophy, one of the first of which was one of my patients who was markedly uræmic and in which the drug showed great improvement from week to week as a result of continuous catheter drainage. Geraghty and Rountree stated in their paper as follows: "The application of this test has brought forward new evidence as to the marked improvement in the renal conditions which accrues as a result of the preliminary treatment introduced some years ago by Dr. Young. Many cases in our series, which on admission showed a very low output under this treatment, show a progressive increase in the amount eliminated. Two cases exhibiting only a trace died of uræmia. In neither case was an operation performed, though clinically at the time of the first test, no evidence of uræmia was detected. The test has made it possible to select a time for operation when the kidneys have regained their full functional power and stability."

Since 1909 when the phthalein test was first used, it has continued to be a routine method of study in all cases in the department of urology at the Johns Hopkins Hospital, and it seems desirable to present here a detailed analysis of my experience with the drug in cases of prostatic hypertrophy. In making this study I have taken advantage of the

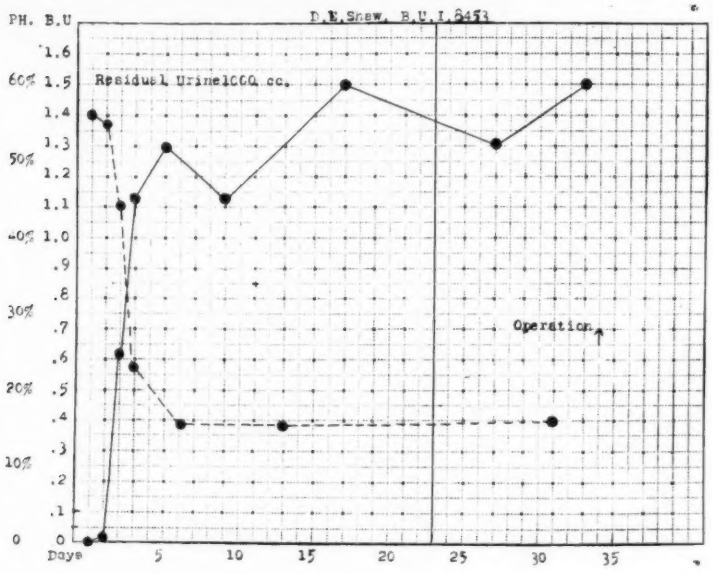

Fig. 1. Chart showing the improvement in the phthalein and the phthalein percentage and the reduction in blood urea as a result of catheter drainage and forced water treatment. There has been a very rapid improvement in this case.

splendid work of Dr. Raymond Pearl and his associates in the department of Biometry and Vital Statistics of the School of Hygiene, Johns Hopkins University. Miss Mary Gover, under the direction of Dr. Pearl, has prepared a most thorough analysis of one thousand cases of prostatic hypertrophy, using the punch card system which has been introduced by Dr. Pearl. Miss Gover's work, which has been most tedious and exhaustive, and has occupied her constantly for 2 years, furnishes endless material for clinical and analytical study in these one thousand cases of prostatic hypertrophy, and has been utilized very extensively in this paper. In the first place I wish to present a study of the phthalein test on admission and again before operation (where more than one test was made). As seen in Table I, Miss Gover has studied 551 cases in which the phthalein tests have been satisfactorily recorded.

The table speaks for itself so that little comment is necessary. Almost all patients with low phthalein on admission were given preliminary treatment consisting of continuous urethral catheter drainage and forced water by mouth or if necessary infusions subcutaneously. The improvement in the phthalein percentage is demonstrated by the figures which show that of those cases with phthalein on admission between 0 and 4 per cent, one, before being operated on, had reached the period between 10 and 14 per cent, two, 20 to 29 per cent, and one 60 to 69 per cent. Of the 16 cases between 10 and 19 per cent on admission, all but four were above 20 per cent at operation. As a matter of fact only 46 were operated upon before the phthalein had reached 30 per cent. One hundred and sixty-two patients (31 per cent) had less than 50 per cent phthalein, and 69 per cent of the cases had over 50 per cent phthalein at operation. About 90 per cent of the cases (all but 6 of the 551) improved so much in kidney function that the phthalein was 20 per cent or more at operation.

In 1913, following the work of Rountree and Geraghty, we began using blood urea estimations in cases with low phthalein tests.

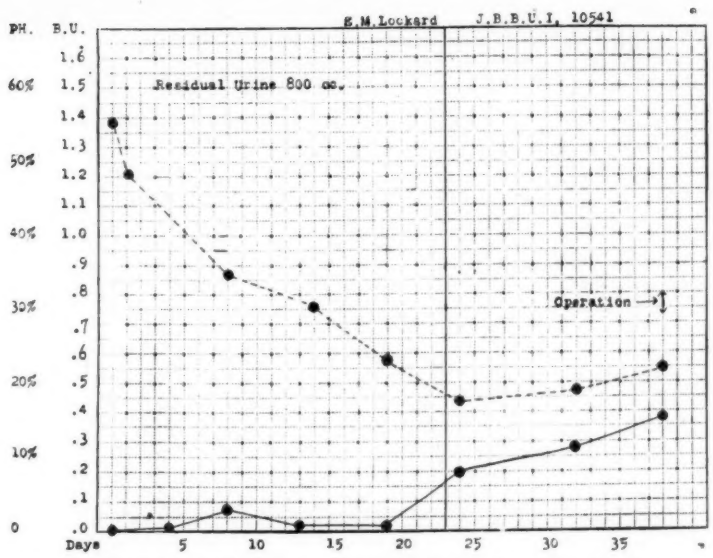

Fig. 2. Phthalein and blood urea. Chart showing much more gradual improvement. The blood urea dropped almost to normal before the phthalein improved at all.

TABLE II.—RESULTS OF CONTINUOUS CATHETER DRAINAGE IN CASES WITH LOW PHTHALEIN AND HIGH BLOOD UREA TESTS

Case number	Residual urine, c.cm.	Retention complete	Phthalein test				Blood Urea		Prep. treat. days	Oper. result cured
			On admission		Before operation		On adm.	B. op.		
			Ap. T. min.	Ph.% in 2 hrs.	Ap. T. min.	Ph.% in 2 hrs.	Gms. per L.	Gms. per L.		
5899	2100	...	30	trace	25	10	1.40	0.26	38	C
5847	550	...	30	trace	20	25	1.20	0.76	47	C
8453	1000	...	..	trace	..	60	1.40	0.40	36	C
6281	....	...	30	trace	..	50	1.05	0.41	26	C
5695	....	R.C.	..	trace	16	24	0.96	0.74	29	C
4032	1300	...	..	9	..	30	0.78	0.50	27	C
5048	830	...	40	15	18	23	0.80	0.36	98	C
4319	250	...	21	19	12	38	0.94	0.64	14	C

Table II gives the details in a group of 8 cases with very low phthaleins on admission. Most of these cases had never been catheterized and had a large residual urine and, in 5 cases with only a trace of phthalein, the appearance time could not be determined on account of the small quantity secreted, but in 4 cases it was much delayed. The blood urea was two to four times the normal, but under continuous catheter drainage it came down to normal (gram .30 to .50 per litre) or nearly so, and the phthalein rose considerably in most cases, the average length of treatment required being 39 days. Suprapubic drainage was not carried out in any of these cases.

In Case 8453, with 1000 cubic centimeters residual urine, the improvement was very rapid, as shown in Figure 1. The large residual, bad phthalein and blood urea tests, caused us to force water, so that he received 5000 cubic centimeters daily, and the high blood urea was literally washed away and was normal in a week. At the same time the phthalein rose to normal, and on the thirty-eighth day the patient went through operation successfully. In another case (10541), Figure 2, with 800 cubic centimeters residual urine, phthalein 0 and blood urea 1.38, the improvement curves were more gradual, and it was not until the thirty-eighth day that the phthalein *reached 38 per cent* and the patient was considered a good operative risk.

The value of this plan of preparatory treatment which I have now used for many years is shown by the fact that there have been 8 cases with only a trace of phthalein, 4 with phthalein 5 to 9 per cent, and 12 with phthalein 1 to 14 per cent on admission with only one death, and that a patient (3412) who had only 12 per cent phthalein in 2 hours on ad-

mission and at the end of 9 days was operated upon regardless of the fact that his phthalein was only 13 per cent. How this slip could have occurred I know not. It is not surprising that he died of uræmia.

I will not attempt here to discuss the question of what the exact nature of the damage is which comes upon kidneys as a result of prostatic obstruction, but a study of Miss Gover's statistics shows that a patient who has a large amount of residual urine has generally badly impaired kidneys, as shown by both renal and blood tests. For example, among 8 patients with phthalein between 0 and 9 per cent the residual varied from 450 to 2100 cubic centimeters in 5 cases, and none had been catheterized, two had led catheter lives for a few months, two for several years and one had a suprapubic urinary fistula. Under continuous drainage and huge quantities of water all improved sufficiently to go through operation successfully.

Among the 15 patients with phthaleins between 10 and 19 per cent only two had complete retention of urine and the highest residual was 830 cubic centimeters, but six were 500 cubic centimeters or more, and only one of these had ever used a catheter.

Among 31 cases, in which the admission phthalein was between 20 and 29 per cent, 6 had a residual above 500 cubic centimeters. One of these had a residual of 1250 cubic centimeters but he had catheterized himself occasionally and the phthalein was 27 per cent and rose after 32 days of preparatory treatment to 42 per cent. Four of the others with residuals of 500 to 700 cubic centimeters had likewise used a catheter once or twice a day, but one patient with 700 cubic centimeters residual urine had had symptoms of prostatic obstruction for 2 years and had never been catheterized—yet his phthalein was 20 per cent and rose in 16 days to 46 per cent when he was successfully operated upon.

The situation may be summarized as follows:

1. Renal impairment is proportional (roughly) to the back pressure in the ureters.

2. This is characterized by dilatation of ureter, pelvis and calyces and thinning of renal cortex.

3. It is most common and most pronounced with large residuals in patients never catheterized.

4. It is less pronounced in large residuals intermittently catheterized.

5. Marked impairment may occur with residual urine less than 400 cubic centimeters but not so frequently.

6. It occasionally occurs with small residuals (less than 100 cubic centimeters) probably due to frequent and prolonged urination during which the ureters are closed and pelvic distention occurs.

The presence of infection may greatly accelerate the renal lesion, and severe cystitis, especially if associated with vesical calculus, adds to the vesical spasm and consequent back pressure. The improvement which follows vesical drainage through a catheter is remarkable, and the rapid fall in retained urea in the blood, and the rise in output of phthalein by the kidneys is one of the most splendid of therapeutic results.

That there is some danger of suppression of urine from the sudden evacuation of a much distended bladder is undoubtedly true and it has been our practice in cases in which we found a residual of over 500 cubic centimeters to force water at once, if necessary by infusions or by rectum. If the phthalein is very low and the blood urea high, intravenous salt solution may be advisable. In such cases I have occasionally, during the past 10 years, elevated the drainage tube so that the bladder empties up hill, so as to maintain an intravesical pressure for a time. Whether this is better than partial emptying and intermittent catheterization I am not sure, for we have encountered some severe uræmias in these cases, which have required drastic treatment. We have lost some three or four cases, autopsy showing great thinning of the renal cortex.

The great bugaboo which has been raised in the literature, viz., post-catheterization hæmorrhage, occurs so seldom as to be almost negligible—but it does occur and apparently comes sometimes from the kidneys. I think catheter drainage is far safer than suprapubic cystostomy in these cases of large residual, because of the possibility of exerting some

counter pressure, or of keeping the bladder fairly filled if necessary. The most important procedure is to provide against suppression by putting the patient into a warm bed at once, and forcing water by mouth and infusion of salt solution. We try to give 5 or 6 litres of water during the first 24 hours and increase to 10 litres a day if signs of uræmia supervene (salt solution by rectum and intravenously, and venesection, if desperate). I have been unable to determine which of the diuretics was most helpful, but make use of several, while depending most on the water cure.

The amazing way in which patients in chronic uræmia with severe mental and gastric disturbance and general systemic breakdown, high blood urea, and no phthalein, may be carried through the post-catheterization crisis to a gradually improving renal function until prostatectomy can be safely done under gas anæsthesia, is one of the triumphs of modern medicine.

I have not the time to do justice to other clinical laboratory procedures such as nonprotein nitrogen, creatinin, carbon dioxide, nephritic diet tests, etc., etc. All of these have a value and are sometimes very helpful, but the phthalein test is certainly the most valuable in telling the clinician and surgeon the functional value of the kidneys, and, if low, a blood urea test will demonstrate any urea retention, which, if present, must be eliminated before operation is undertaken. The simplicity and accuracy of these two tests make them most satisfactory.

Early in my experience with the phthalein test in cases of prostatic hypertrophy, we discovered that no hard and fast standards, below which it would not be safe to operate, could be insisted on. A review of Miss Gover's tabulations shows 27 cases in which the phthalein was below 30 per cent at operation with 3 deaths, a mortality of about 11 per cent. These patients came 10 years ago, before we began insisting on blood ureas in all low phthaleins, and, by some strange mischance, were treated only 9, 13, and 18 days, respectively, before operation. Unquestionably more prolonged efforts to improve renal function, checked by blood ureas, should have been made.

There are cases in which it is impossible to get the phthalein as high as 30 per cent, but if a prolonged effort has been made, the blood urea is not over gram 0.50 per litre and symptoms of uræmia are absent and water will be tolerated in large quantities, I have found that such cases go through operation well. As shown in Table I, out of 551 cases, at operation all but 27 had a phthalein of over 30 per cent and only 35 between 30 and 39 per cent. The lower the phthalein at operation the higher the mortality. If possible the operator should wait until the test is over 30 or 40 per cent before carrying out prostatectomy.

INFECTION

Infection is responsible for a large number of the fatalities in prostatics. In early cases the patient comes in with a small or moderate amount of residual urine which is usually sterile. If a catheter has been used, cystitis is almost always present. In many cases it is mild—simply a bacilluria due to the colon bacillus; in others a moderate pyuria is present, and in more severe cases this is accompanied by a large amount of pus and often with other organisms present—staphlococci, rarely streptococci, and occasionally, if the urine is ammoniacal, the proteus bacillus.

When the infection has spread to the prostate and seminal vesicles it may produce an abscess, but usually only a chronic prostatitis and vesiculitis. If the infection reaches the kidneys, a pyelitis, or pyelonephritis may seriously complicate the case.

Infection is frequently present in cases that have not been catheterized, particularly if the residual is great. Almost all cases become infected after prostatectomy, and statistics seem to show that cases with a mild cystitis run a smoother postoperative course and are less subject to fever and toxæmia than the previously sterile cases. One of the most annoying complications is epididymitis, which occasionally follows instrumentation, especially frequent or continuous catheterization, before or after operation. In my statistics it occurs in about 20 per cent of the cases.

Although some urologists have held it desirable to have the bladder become infected before operation—to have the general and

tissue reactions established and over with before prostatectomy—the danger from a virulent organism, especially a coccus infection, is such that strict asepsis should be the rule in instrumentation and also at operation. Besides cleaning up the external genitalia the anterior urethra, which is the habitat of both bacilli and cocci, should be sterilized by injection—I use a 1 per cent meroxyl which is as germicidal as bichloride of mercury, works in the presence of albumin, pus, and urine, and is non-irritating.

CATHETER DRAINAGE

Catheter drainage need not be given to those cases with a good phthalein and slight residual urine (100 cubic centimeters, and occasionally more, in patients in prime condition). In such cases after perineal prostatectomy we irrigate the bladder with 1:1000 meroxyl, or other mild antiseptics, through the drainage tube several times before removal of the tube on the first or second day after operation. The urethra and wound are similarly irrigated to hold down infection and lessen the danger of epididymitis. The orderlies irrigate the wound externally at each change of the dressings. In a few cases we have succeeded in carrying a patient through the pre-operative treatment, operation and convalescence with sterile urine, but in almost all cases a bacillus coli infection occurs. Where the phthalein is below 50 per cent or the residual pronounced (say over 200 cubic centimeters) or the patient's condition such as to call for preparatory treatment, a rubber catheter, No. 18 or 20 F., is inserted for continuous drainage and the bladder irrigated twice daily with 1:1000 meroxyl, or 1:8000 acriflavine or 1:60,000 bichloride of mercury twice daily. Catheters are changed every 3 days with a 3 to 4 hours' interval between removal and reinsertion—during which time the urethra is also irrigated.

If catheter drainage is maintained a week or more, a bacillus coli infection generally occurs, regardless of the careful antiseptic technique. Cases already infected are usually improved by catheter drainage and irrigation twice daily, and severe cystitis should be vigorously treated before operation unless accompanied by calculus, in which case it is almost useless.

SUPRAPUBIC DRAINAGE

Suprapubic drainage may be required in these calculus cases, especially if associated with a lowered phthalein and not tolerating a retained catheter, while requiring preparatory drainage. A study of my 1049 cases shows that a preliminary suprapubic drainage has been done in 11 cases—about 1 per cent—the usual cause being an irritable bladder or urethra which made catheter drainage intolerable. Not infrequently great care in adjusting the catheter and occasionally frequent changes had to be made during the catheter drainage. At times considerable urethritis would be engendered especially in prolonged cases. By resorting to intermittent catheterization, urethral injections of mild antiseptics and oils, almost all cases requiring drainage can be successfully handled by urethral catheter, as shown by the fact that I carried out suprapubic drainage in only 1 per cent of the 1049 cases. But why not do suprapubic cystostomy and insert a drain and be relieved of all the bother of a urethral catheter? Well one might reply:

1. Suprapubic drainage also requires considerable attention.

2. It is, I believe, contra-indicated in cases of large residuals and very low phthaleins where suppression is feared.

3. It is associated with a mortality of its own of at least 2 per cent. (Gardner says 3 per cent.)

4. As most cases require drainage 3 weeks or more, the suprapubic scar tissue is more of a hindrance to suprapubic prostatectomy than the fistula is a help.

5. Urethral catheter drainage is the safest and most satisfactory method. Unquestionably, however, some cases should be subjected to suprapubic cystostomy. What are these? In the last 3 years and 6 months the entire admissions for prostatic hypertrophy cases to the Johns Hopkins Hospital have been about 400, and among these there were 12 patients who died without undergoing prostatectomy. These cases presented many interesting problems, and I wish to discuss

TABLE III.—TWELVE CASES ENDING IN DEATH DURING PREPARATORY TREATMENT

Case No.	Hosp. No.	Symptoms	Condition	R. U.	Phthal. % 2 hrs.	Blood ur. gr. per L.	Urine inf.	Lived days	Cause of death. Autopsy
1	7630	Freq. urination, vomiting. Gen. debility	Bad. Uræmia	250	10	1.08	Bacil.	6	Uræmia, nephritis, diabetes
2	7793	Incontinence of urine	Fair. No uræmia	1000	17	0.48	Bacil.	28	No autopsy. Catheter not well borne. Fever. Infec.
3	8075	Freq. ur. Comatose	Bad. Uræmia	500	15	2.40	Bacil.	16	Uræmia. Autopsy: pyelonephritis
4	8338	Dysuria. False passage	Bad. Fever, uræmia	1200	0	0.88	Bacil.	16	Op. suprapubic drain. Autopsy: pyonephrosis
5	8381	Frequency great, pain, dysuria	Fair. No uræmia	500	..	0.36	Bacil. cocci	11	Autopsy. Abscess of prostate, sepsis
6	8585	Stupor, uræmia	Suprapubic drain, 2 mos.	S. Dr.	17	0.76	Bacil.	23	Uræmia, myocarditis, heart block
7	9005	Retention, stupor, fever	False passage, fever	500	..	0.60	Cocci bacil.	2	Sepsis, heart dis., uræmia. No autopsy
8	9067	Retention complete	Fair. No uræmia	600	15	0.84	Cocci	5	Sudden death. Autopsy: pulmonary embolism
9	9311	Freq. urination. Œdema, feet	Weak. Short of breath	800	..	....	No	2	Autopsy: nephritis, myocarditis
10	10112	R. C. Drowsy	Bad. Mind clouded	900	30	0.50	Cocci bacil.	44	Autopsy: pyelonephritis
11	10173	Freq. urin. Weakness	Fair. Clear	1040	30	0.37	Cocci	12	Died of uræmia. No autopsy
12	10555	Freq. urin. Vomiting	Pale. Left kidney enlarged	500	..	2.16	Cocci bacil.	3	Died of uræmia. No autopsy

them in detail. As shown in Table III, in which these cases are given in abstract, five (Cases 1, 7, 8, 9, and 12) died within 6 days of entrance to the hospital, and three on the second day. Note the high blood urea, the low phthalein, the large residual, marked uræmia, and death from nephritis plus infection. In Case 8 the renal function was improving when sudden death from pulmonary embolism occurred. In other cases bladder drainage seemed to accelerate the onset of uræmia, in one case, regardless of the fact that realizing the danger of suppression as soon as I found 500 cubic centimeters residual urine present and no phthalein secreted, I began forcing water in every way. I did not, however, elevate the drainage tube so as to maintain bladder pressure, and this procedure might have saved some of them—as I have had many more desperate cases survive and later go through prostatectomy.

Several cases did not tolerate a catheter well, began to have fever and other signs of infection, and at death showed prostatic abscess or pyonephrosis. Cases 2, 5, and 10 belong to this group and might have been saved by a suprapubic operation under local anæsthesia. Two patients whose urethræ were badly traumatized by previous attempts at catheterization (Cases 4 and 7), should have had prompt suprapubic drainage and perhaps Case 4 might have been saved, for a suprapubic done 5 days after entrance did not save him—autopsy showed abscess of the prostate and of both kidneys.

Many of these cases were almost moribund, with kidneys practically destroyed by back pressure and infection when admitted. During this period I had in my own service two of these patients (Cases 4 and 12 above), the former of whom might possibly have been saved by more prompt measures.

Infections about the perineal urethra, the prostate and seminal vesicles are most important as portals of entry for an ascending or general sepsis, and house officers are instructed to be on the lookout and to make rectal examinations in the event of unexplained fever during the period of catheter drainage. Epididymitis usually subsides without operation, but may require drainage, and rarely may necessitate suprapubic cystostomy to do away with the inlying urethral catheter.

If prostatovesicular or retrovesical abscess occurs it should be drained perineally and the bladder opened suprapubically if the case is serious. Prostatectomy should not be carried out in the presence of prostatic abscess,—I lost one such case from a generalization of the infection.

RÉSUMÉ AS TO DRAINAGE

Cases in good condition, with good phthalein and small residual (200 cubic centimeters or under) may be operated upon without preliminary drainage or more than ordinary surgical preparatory treatment. Of my 1049 cases 462 were operated upon within 4 days of admission.

Cases with moderate or high residual, even if phthalein is good, should have preparatory drainage, and forced water treatment, but may often be operated upon in a week, if clinical and laboratory studies are propitious.

Cases with marked impairment of renal function, 30 per cent or less, should not be operated upon until phthalein has risen over 40 per cent or a prolonged treatment (3 weeks or more) has shown that the optimum has been reached, the condition of kidneys stable, the blood urea not over 0.5 gram per litre, and general condition fair. Six of my cases were under 20 per cent with only one death—but all but this one had proper preparatory treatment.

Cases with high blood urea (over 0.75) should receive most energetic treatment—(7000 to 10,000 cubic centimeters of water, by all avenues, daily) and the same applies to cases with renal infections, especially acute pyelitis which we have frequently washed away by forced internal hydrotherapy.

Cases with spasmodic, painful, or contracted bladder or urethra, some cases with calculi and occasionally with diverticula, tumor, ulcer, or severe cystitis, and also cases very difficult or painful to catheterize or tolerating an inlying catheter badly, with pronounced suppuration and epididymitis, often require suprapubic drainage.

In the two-stage suprapubic operation, the first stage is often the most dangerous, and in my opinion it is not justified as a routine procedure.

Almost every case can be brought into condition for perineal prostatectomy without a first stage suprapubic drainage. (In my 1049 cases only 11 had suprapubic drainage—1 per cent. In my last 200 cases only 2 died before operation, Cases 4 and 12 above, and none after prostatectomy.)

Occasionally one sees a very old or feeble man who is doing very well with a catheter life, to which he is well accustomed, and it seems safer to leave him alone. About 1 per cent of the cases are sent home thus without prostatectomy, which as a whole has now a much lower mortality than the catheter life.

Diabetes, acidosis, etc. Occasionally the diabetic has an obstructing prostate and the question of operative safety must be considered. I have had 12 cases in my series of 1049, and all have gone through operation and convalescence successfully. Most of the cases have been mild, but others have presented from 2 to 4 per cent sugar, and have required fairly energetic, prolonged antidiabetic treatment before operation could be undertaken safely. This treatment in addition to water in large amounts and soda has been entirely satisfactory, and from our experience we feel that practically all cases can eventually undergo perineal prostatectomy safely. The things to be avoided are ether anæsthesia, prolonged operation, hæmorrhage, and infection. I use gas and oxygen, and believe the perineal operation much safer because of the ability to stop hæmorrhage, secure dependent drainage, combat infection and prevent sloughing. The postoperative handling must be very alert and vigorous, especially if symptoms of coma appear.

Cardiovascular disease is very common in cases of prostatic hypertrophy. The well recognized cardiorenal relationship would lead us to expect it when 43 per cent of the cases have renal impairment below 50 per cent phthalein. Arteriosclerosis is so very common as to be negligible except in the very severe grades. Even with a history of previous cerebral attacks, or "apoplectic strokes," it is possible to carry out perineal prostatectomy successfully. In my histories there were more than ten cases in which one or more "strokes" with "paralysis" had occurred

before admission, and among these there were no deaths.

The blood pressure encountered is shown in the following table of my 198 consecutive cases without fatality.

TABLE IV.—SHOWING SYSTOLIC BLOOD PRESSURE IN LAST SERIES OF 198 CASES OF PROSTATIC HYPERTROPHY

	Cases		Cases
100–109	5	160–169	19
110–119	12	170–179	15
120–129	24	180–189	10
130–139	29	190–199	6
140–149	41	200–209	2
150–159	24	210–219	3

As seen here there are 55 cases in which the blood pressure was over 160 (27 per cent) and 5 over 200. That high blood pressure is not without danger, I know from two hemiplegic deaths in my longer series, immediately after operation (one a blood pressure of 220). Rest in bed, reduced diet, and, to a slight extent, drugs often reduce blood pressure considerably. Excitation before operation should be avoided, and morphia, given in the ward, is very valuable for this purpose. In these cases I always use "straight ether anæsthesia." Ether is a good cardiac stimulant and increases the blood pressure less than nitrous oxide. Spinal anæsthesia depresses it and some have advised its use in these cases, but I have no experience to offer.

Although high blood pressure is recognized as a signal for thorough study and great care at operation, I have found it possible to operate on practically all of these cases, even with a history of previous "paralytic stroke."

Heart disease was present in 48 per cent of my 198 cases (heart enlargement 17 per cent, murmurs 15 per cent, enlargement and murmurs 8 per cent, myocarditis 8 per cent). In most of the cases the lesion was not grave, no special treatment was given and nitrous oxide anæsthesia was employed. In other cases the condition was very serious, and great care was taken to get the patient in best possible trim under the direction of a competent internist, who usually administered to the patient before and during anæsthesia and after return to the ward. I will not attempt to describe the special therapeutics employed. From the urologist's standpoint it is interesting to know that almost all of these cases stand operation well and in 1049 cases there was only one operative cardiac death (patient died suddenly a few hours after operation).

But whereas patients with severe valvular lesion, dilatation, broken compensation and auricular fibrillation have been carried through perineal prostatectomy successfully, I will admit that an occasional patient, in very bad condition, who had learned to use a catheter successfully, was sent home without operation—but the sum total of these is very small.

Respiratory infections are extremely important to the surgeon, and in the face of an acute inflammation of the nose, throat, trachea, bronchi or lungs, we always delay operation to give the infection a chance to clear up. If fever is present, even 99.5° F., and the respiratory tract is suspected, operation is postponed. Where the infection is chronic, after appropriate treatment, the operation is done under gas and oxygen. Ether is certainly far more dangerous in these cases, and the use of gas-oxygen for 7 years has certainly cut down the number of pneumonias. Perhaps spinal or local anæsthesia may sometimes be indicated—certainly it is in tuberculosis of the lungs (I had one such death after ether) and pleurisy. The use of an antiseptic mouth wash and gargle (e.g., meroxyl 1:500) and medicated vaseline for the nose before anæsthesia deserves serious consideration as a preventive procedure.

Pulmonary embolism was responsible for one death during preparatory treatment and six after operation. It is a frequent cause of death in all operations below the umbilicus (I have seen it follow a simple varicocele and a suprapubic cystotomy). One patient died 3 weeks after perineal prostatectomy of pulmonary embolism immediately after taking an enema (and I know of other such occurrences). This has caused me to forbid enemata after all operations below the umbilicus. It is not clear how these accidents are to be always prevented, but straining in micturition, as well as at stool, is to be avoided, as well as infection and secondary hæmorrhage.

Technique

In a recent paper[1] I have discussed at length the various modifications in technique which I have made since its inception, and the reader is referred for details to that paper from which some illustrations have been taken. Suffice it to say here that only minor changes have been made in the technique. As now carried out the exposure is still through an inverted U perineal incision and reaches the prostate by blunt dissection on each side of the central tendon, opening up the space behind the transversus perinei muscles and triangular ligament, and after division of the median line structures (central tendon and recto-urethralis muscle,) the posterior surface of the fascia of Denonvilliers is exposed. Division of the posterior layer of this fascia gives the entrance into the space between the two which, in fœtal life, were peritoneum, and opens up a ready access to the prostate, seminal vesicles, and vasa deferentia. The advantage of this exposure over the old median line perineal incision is that the hæmorrhagic bulb is avoided, the external sphincter and triangular ligament are spared, the anterior surface of the rectum is visible and can be readily avoided, and the prostate is exposed to the light of day so that accurate operative procedures can be carried out. By means of the prostatic tractor introduced through the posterior part of the membranous urethra or the apex of the prostate, the hypertrophied mass can be drawn down into the field, and any technique which pleases the operator carried out in their enucleation. The original bilateral capsular incisions, which were used for many years, are splendid in preserving intact the verumontanum, ejaculatory ducts, and urethra, but have the drawback of requiring that the prostatic lobes be removed separately. In so doing it is more difficult to carry out a radical procedure upon all the hypertrophied masses present. Therefore we now open the urethra boldly by means of an oblique lateral or an inverted V incision (Fig. 3), and thus make it possible to enucleate in one piece the entire adenomatous hypertrophy including also the anterior commissure if this is involved. A little more mucous membrane is injured, but the ejaculatory ducts are preserved with equal certainty, and a far better chance is given to remove every vestige of the hypertrophied tissue and without injury to the neck of the bladder and internal sphincter (Figs. 4 to 13). By this technique it is possible to follow the hypertrophied tissue beneath the trigone and to remove a group of glands which, when hypertrophied, are usually not removed (Fig. 8) by the suprapubic operation and remain to give trouble with future obstruction. In some of our perineal operations, by the previous bicapsular technique, hypertrophied tissue was left in this region so that the method which we are now pursuing should give a definitely more perfect series of results and without necessitating the deep division or excision of tissues at the floor of the vesical neck, the sphincter and apex of the trigone as advised by Thompson-Walker and by some surgeons in America who follow the suprapubic route. (Figs. 5, 6, 7, and 8, frontispiece.)

The technique here referred to is graphically shown in the accompanying illustrations so that an extensive comment is unnecessary. The 1049 cases which we wish to analyze here have been done by the same technical method with the exception of the incisions in the prostate itself and in the urethra as above described. The results, therefore, will not be absolutely uniform in so far as the latter technique is more radical and it gives the

TABLE V.—SHOWING RELATION BETWEEN AGE AND MORTALITY AFTER PROSTATECTOMY

Age years	Cases	Deaths	Percentage
30 to 34	1	..	...
35 to 39	3	..	...
40 to 44	2	..	...
45 to 49	10	..	...
50 to 54	52	2	3.8
55 to 59	140	1	.7
60 to 64	217	6	2.7
65 to 69	264	10	3.7
70 to 74	213	6	2.8
75 to 79	113	6	5.3
80 to 84	28	2	7.1
85 to 89	2	2	...
90 to 94	1	1	...
Not given	3	..	...
Total	**1049**	**36**	**3.4**

[1] Technique of prostatectomy in its relation to mortality. J. Am. M. Ass., 1922, Apr., 933.

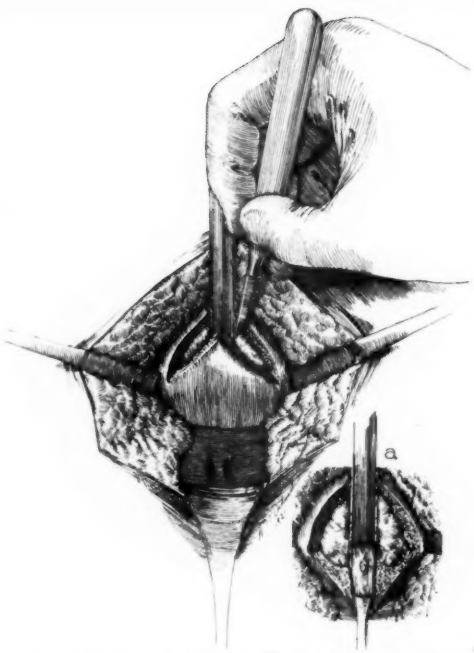

Fig. 3. Division of the left lateral wall of the urethra with scalpel. This is carried out also on the right side, thus making it possible to draw down the triangular flap with forceps and expose the floor of the urethra and ejaculatory ducts, as shown in inset, *a*, in which the urethra is divided on each side, the fold carried downward, and the lateral adenomata exposed.

operator a better opportunity to see points of bleeding, to arrest hæmorrhage, to place packing, etc.

Age as a causative factor of mortality is graphically shown in Table V. A glance at this table shows us that, with negligible variations, the mortality rate per cent increases gradually in each decade of life, but up to 75 years of age it remains very low, 2.8 per cent. After 75 years the operation is definitely more dangerous, but it is interesting to note that, during the last series of 198 cases without a death, there were 18 patients over 75 years of age (6 over 80)—all of whom went home well. Several successful prostatectomies in men over 90 years of age are recorded. One of my patients who had reached the age of 93 died, 2 weeks after operation, of cerebral thrombosis—apparently not associated with the operation.

Fig. 4. Enucleation of lateral lobes begun with blunt dissector.

Postoperative Treatment

The results of this can best be portrayed by a mortality chart (Fig. 14). In 1049 consecutive cases there were 36 deaths in the hospital, a mortality of 3.4 per cent. In the accompanying chart the death rate has been charted by the succeeding years, the number of cases, and the deaths for each year being given, and from these the death rate, per cent, has been calculated and charted. This chart is interesting as showing a gradual decline in the mortality among my perineal prostatectomy cases from 8.4 per cent in 1903 to 2.4 per cent in 1919, and to none since then. During the 20 years included in the chart there have been two long periods in which there were no fatalities, first in the year 1906–1907 and part of 1908 in which there were 128 consecutive cases without a death (4 patients being over 80 and 43 over 70 years of age), and the second from February 8, 1919, to October 15, 1922 (when this paper was prepared), during which there were 198 consecutive cases without a death. During this last period there were only four patients in which operation was not carried out, and two of these died in the hospital (*vide supra*).

The pre-operative treatment by which these cases were prepared for a successful operation has been outlined. The post-operative complications may be grouped under

TABLE VI.—CAUSE OF DEATH AFTER PERINEAL PROSTATECTOMY IN 1049 CASES

Principal cause of death	Cases	Per-centage	Complications
Pneumonia	8	22	Old tuberculous lung, 1; myocarditis, nephritis, 1; pyelitis, uræmia, 1.
Acute pulmonary œdema	1	..	Patient has recently recovered from pneumonia.
Uræmia	7	20	Hydropyonephrosis, 1; hæmorrhage from nose, 1; pneumonia, 1; hydronephrosis, double, 1.
Pulmonary embolism	4	12	Clot in heart and vena cava, 1; nephritis, dilatation heart, mural thrombus, 1; coronary thrombosis, 1; thrombosis femoral vein, 1.
Cerebral hæmorrhage	3	8	Marked arteriosclerosis general, 1; grave fear of operation, great mental excitement, 1.
Cerebral thrombosis	2	6	In one case, man, age 92, thrombosis followed 12 grains of aspirin 3 weeks after operation.
Heart disease	1	..	Myocarditis, dilatation of heart, pyelonephritis.
Endocarditis	1	..	Bronchopneumonia.
Hæmorrhage of wound	2	6	One case immediately after operation, due to insufficient packing; other case, secondary hæmorrhage at end of week.
Hæmorrhage from nose	1	..	Hæmorrhage from nose came on suddenly 3 weeks after operation when wound was healed.
Sepsis	2	6	
Abscess of spleen	1	..	Bronchitis.
Tuberculosis of lungs	1	..	Arrested case of pulmonary tuberculosis, ether anæsthesia, should have been operated upon under spinal.
Extravasated urine	1	..	I made mistake of incising orifice of the diverticulum and as a result perivesical extravasation occurred.
Cancer of intestine	1	..	Patient died of intestinal complications; necropsy showed large unrecognized cancer of sigmoid.

various heads which may be discussed after giving a classification showing the cause of death in the 1049 cases charted in Table VI.

Our hindsight is better than our foresight. It is easy now to look over the above list of fatal endings and see how many of them should not have happened: for example, in the last mentioned, the carcinoma of the sigmoid should have been discovered and no operation performed. In the case above it, the extravasation came from an incision made in the neck of a diverticulum—a great mistake! The next with tuberculosis of the lungs should not have been given a general anæsthetic, etc., etc.

And it is a fact, as shown by the two long periods which were without a fatality, that by exercising the greatest care almost every patient can be prepared to go safely through perineal prostatectomy.

SHOCK

The prevention of operative shock is of great importance, and when we consider that about 40 per cent of the patients are over 70 years of age and many of them very feeble, we realize that great care must be taken. Our patients receive water in abundance up to the time of going to the operating room. This does not seem to lead to nausea or vomiting and prepares against the loss of blood. By quick operation, careful hæmostasis, ligation of bleeding arteries in the capsule of the prostate if possible, and thorough control of the bleeding after the drainage tube has been introduced, either by packing within the capsule and vesical sphincter or by pressure against the capsule posteriorly, the patient should leave the table in good condition with the hæmorrhage stopped. The operator should see to it that the hæmorrhage is controlled, and in some cases we put as many as 12 strips of gauze packing in order to secure this, but it is important that it should be persisted in until the hæmorrhage is controlled. One of the great advantages of the perineal route is that this is possible. Should the patient's pulse be very weak, an infusion or intravenous transfusion should be started before he leaves the operating room, and it is our invariable rule to give submammary infusions to every case on return to the ward. Should subsequent development show that the packing has not been sufficient to stop hæmorrhage, additional gauze should be introduced, preferably with a tubular packer which, when introduced deep into the cavity of the prostate, makes it possible to insert a large amount of gauze in the proper place without danger of injury to the rectum. In very feeble patients it is our rule to have blood matching done before operation, and if possible have a member of the family ready to give blood. Occasionally transfusion is resorted to with amazing results. Secondary hæmorrhage, following removal of gauze on the first or second day after the operation or sometimes later, may lead to considerable shock, which should be handled by repacking, infusion, or blood transfusion as necessary. In one of our cases hæmophilia gave us a great deal of trouble.

Fig. 9. *A*, Anterior view of lateral and median lobes removed in one piece; *B*, side view of right and median lobes of specimen; note the constriction of median lobe by sphincter and small subtrigonal posteriorly projecting lobule; *C*, vesical aspect of prostate, showing the small intravesical median and very large extravesical lateral lobes; if this had been removed suprapubically, the sphincter would have surely been destroyed.

Fig. 10. Specimen removed by foregoing technique, consisting of very large left lateral (*L. L.*), moderated right lateral (*R. L.*), and very long median lobe (*M. L.*), which projects far into the bladder. No mucous membrane removed.

As seen in the above chart there were two deaths from hæmorrhage: one on the day after operation and another 6 days later. The first could have been prevented by more packing which was very inadequately done in this case. The latter case was a secondary hæmorrhage which could not be controlled even by suprapubic cystostomy and packing.

PULMONARY COMPLICATIONS

As seen in Table VI pneumonia has been the most frequent cause of death, 22 per cent. A few of these were ether pneumonias, but, since the introduction of nitrous oxide-oxygen anæsthesia, operation-pneumonias have not occurred, but several cases have developed pneumonia in 2 or 3 weeks after the operation. The prevention of these complications is difficult. It is important that the patient should be up and about, as it is dangerous for old men to be in bed, and on this account it is our rule to get them out of bed in a few days, and have the patient walking within a week or 10 days. Great care should be taken to avoid chilling, exposure to cold, and association with others who have acute respiratory infections. The use of gargles and mouth washes and oil in the nose is also of much help.

Uræmia, which has been the cause of death in 20 per cent of the cases, is a direct result of the serious impairment of the kidneys from back pressure or infection which is generally present before operation, but may result from ascending infection after operation. One must take grave risks of uræmia occurring, but by prolonged catheter drainage, and the use of water in large amounts, the patient can usually be brought into a safe condition for operation. It is absolutely essential, however, that the imbibition of water should continue after operation, and if nausea or refusal of the patient to drink should interfere, salt solution should be given by infusion or by rectum or by transfusion, and, if the onset of fever and localizing symptoms indicate that a pyelitis has supervened, the water cure should be forced with redoubled activity by every possible means. I have seen numerous cases in which this has occurred, and it is most extraordinary how it is possible to wash away acute renal infections and severe uræmias.

Nausea and hiccough, on account of their interference with the "water cure" are of

Fig. 11. Enucleation of prostate *en bloc*, with anterior commissure intact. *A. C.*, Anterior commissure.

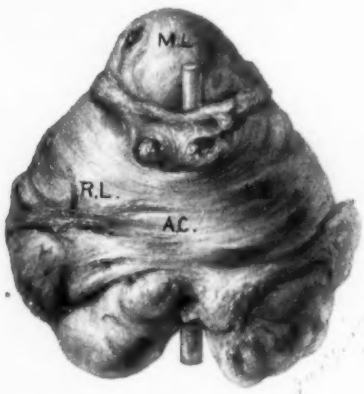

Fig. 12. Anterior view of hypertrophied prostatic lobes removed *en bloc* with anterior commissure and a portion of the prostatic capsule; glass tube shows site of urethra.

very great importance, and should be combated most vigorously. The use of a stomach tube is often of great help, and when one drug will not work another should be tried, especially in cases of hiccough. In my opinion there is no one specific.

CIRCULATORY COMPLICATIONS

Cardiovascular complications are of the next importance. Pulmonary embolism was the cause of death in 12 per cent of the cases. It sometimes occurs as a result of endocarditis or other cardiac diseases, but as a rule the clot comes from the region of the wound. Two such cases followed the taking of enemata and one case followed a femoral thrombophlebitis. Phlebitis of the veins of the leg occurs occasionally and should always receive the greatest care; the patient should be kept absolutely quiet until the danger of embolism has passed.

Cerebral hæmorrhage occurred in three cases. When we realize that fully 50 per cent of the patients have arteriosclerosis and abnormally high blood pressure, it is remarkable that it does not occur more often. Two of these patients were found to be hemiphlegic immediately after the operation; one had a very high blood pressure—over 220, and the other was a man who was extremely nervous and fearful of death. *Cerebral thrombosis* occurred in two cases. One, a man aged 92, was up and about and almost ready to go home 3 weeks after operation. He complained of some pain in his wound, and was given aspirin. He died very soon, and autopsy showed cerebral thrombosis. An explanation of death in this case was that the aspirin had lowered the blood pressure and slowed up the pulse, so that thrombosis in the sclerotic cerebral vessels occurred.

Heart disease was immediately responsible for only two deaths, and when we consider that fully 50 per cent of the patients were suffering from cardiovascular disease, and many of them with grave cardiac lesions, as stated previously, it is remarkable that there were not more. Surgeons have long been aware that cases with heart disease go through operation under ether anæsthesia with remarkable facility, and on this account we have operated on many a patient in which a cautious clinician has advised against operation. It is extremely important, however, to take every care, and to have the assistance of the best internist, because much can be done with digitalis, quinidine, and other drugs to get the patient in trim for operation and to carry him safely through the convalescence.

INFECTION

There is no more important feature of the treatment than the prevention or combating of sepsis. As stated before it is almost impossible to carry out frequent or long-continued urethral or suprapubic drainage without infection. The colon bacillus is the most common organism and is usually not very virulent. Efforts should be made to prevent cocci from being added to the infection, and this can usually be done. The colon bacillus may, however, produce very severe cystitis, prostatitis, epididymitis, and ascending renal infections. Of these, epididymitis is the most frequent and may be sufficiently severe to require incision and drainage, especially if the patient is feeble or if he continues to run fever or show evidences of considerable toxæmia. The great majority of the cases, however, can be controlled by ice packs and resolve without operation. Infection of the wound and bladder should be treated by mild irrigations, preferably of some of the newer antiseptics, meroxyl 1:2000, acriflavine 1:8000, mercurochrome 1 per cent or Dakin solution (if accompanied by breaking down or sloughing of the wound). It is rare now to see the nasty perineal and suprapubic wounds, encrusted with urinary salts and accompanied by necrotic tissue, such as we used to see so frequently. Ammoniacal cystitis, with its rapid deposit of phosphatic calculi, is practically a thing of the past as a result of modern antiseptics. Hexamethylenamin is of slight value, unless given in large doses and in conjunction with sodium benzoate.

Ascending infections of the kidney pelvis and cortex can usually be dealt with by internal hydrotherapy, submammary and intravenous infusions often being necessary. Occasionally a definite abscess forms or the condition becomes so serious that a hasty drainage operation is necessary.

The use of drugs intravenously to combat sepsis looms up as a method of the future. Piper has reported 4 cases of septicæmia, due to the streptococcus hæmolyticus and one to the staphylococcus aureus, which had been cured by the intravenous injections of mercurochrome 5 milligrams per kilogram of body weight, 1 per cent solution being employed. We have recently had one case of general colon bacillus septicæmia cured by 34 cubic centimeters of a 1 per cent solution of mercurochrome. These remarkable results should lead to the wide use of this drug to combat general infections. To accomplish results, however, full dosage, as employed by Piper, should be adopted. Other antiseptics, collargol, silver iodide, etc., have been employed for similar purposes.

Fig. 13. Moderate hypertrophy of the lateral lobes with long middle lobe removed with anterior commissure.

GASTRO-INTESTINAL COMPLICATIONS

Nausea, vomiting, distention due to obstruction, or severe obstipation present problems of the greatest importance and have required minute attention and vigorous treatment. The use of gas anæsthesia has done away with almost all of the postoperative nausea and vomiting, and it is possible to have the patient drink water in abundance early. In this way uræmic vomiting is prevented in most cases. Abdominal distention from obstipation or intestinal obstruction or undue gas formation, is nothing like so common from perineal as from suprapubic prostatectomies, but it

may be a most serious complication, and every effort should be made to prevent its occurrence A few doses of white oil before and immediately after operation, followed by a gentle purgative is generally sufficient, but if the bowels become greatly distended, the use of a urethral catheter inserted high into the rectum and pituitrin supplemented with hot stupes, and other appropriate measures has usually been effective in our cases. Enemata of course would be useful, but owing to two deaths from pulmonary embolism following enemata their use has been prohibited upon operations of the pelvic organs and genitalia at my clinic.

CARE OF WOUND

The care of the wound has been made extremely simple in cases upon whom perineal prostatectomy has been done. The drainage tubes and gauze are generally removed within 24 or 36 hours after operation and are not replaced, urine being allowed to escape through the lateral perineal wound, which is irrigated superficially with a mild antiseptic by the orderly at each change of the dressing and after bowel movements. Five or six days after operation fluid is forced through the penile urethra so as to open up the membranous urethra and prepare the way for the closure of the wound. Passage of sounds is not necessary and is only adopted when 2 weeks or more after the operation normal urination has not been established and it seems evident that the urethra has become coapted or contracted in the membranous region in front of the urethrotomy. But even then the instrument is only passed through the membranous urethra, and no attempt is made to enter the bladder, as it is advisable not to traumatize the verumontanum for fear of producing an epididymitis. In rare instances a blood clot or swelling of the internal sphincter may lead to obstruction and require the insertion of a catheter through the urethra or drainage tube through the perineal wound, and in some cases in order to hasten the closure of the fistula a retained urethral catheter may be employed. The patient is allowed to be up and about as drainage is best when in sitting or standing posture.

CLOSURE OF FISTULA

This is usually spontaneous and within the first 3 weeks after operation. In our experience 23 per cent closed within 14 days, and a persistent fistula is extremely rare and does not furnish the bugaboo which has been held against the perineal operation by certain writers. As a matter of fact it is not so common as a persistent suprapubic fistula in my experience, and is infinitely less disagreeable as there is no continuous leakage as in suprapubic cases, but only the escape of urine at urination, patient being dry the rest of the time. In a very exhaustive study of 450 cases I have found only 5 in which the fistula was present after prolonged period; three of these were paupers, and had not received proper treatment after leaving the hospital. The use of the curette is of assistance in hastening the closure of fistulæ and a sound should be passed so as to be sure that no stricture or valve formation is present in the urethra.

Although we are insistent that the patient remain in the hospital until the fistula has been closed 3 or 4 days, 64 per cent of the patients have left the hospital inside of 4 weeks and only 5 per cent have remained more than 8 weeks. When we consider the great age and serious condition of many of these patients, this shows that the convalescence from perineal prostatectomy is comparatively short and simple.

In some cases we have tried to render the bladder, which is practically always infected, sterile by treatment, and in a few instances have succeeded in killing off all bacteria in a few treatments. In most cases, however, this is impossible and as a rule we depend largely upon the abundant drinking of water and time to eradicate the bladder infection. It is remarkable how many return after a few months with sterile urine. If a severe cystitis is present and particularly if it is alkaline with a tendency to a deposit of lime salts, irrigations with or without a catheter may be advisable and here the newer antiseptics, above referred to, are of great value in conjunction with nitrate of silver and permanganate of potash.

The act of micturition, which is materially altered by the considerable impairment or

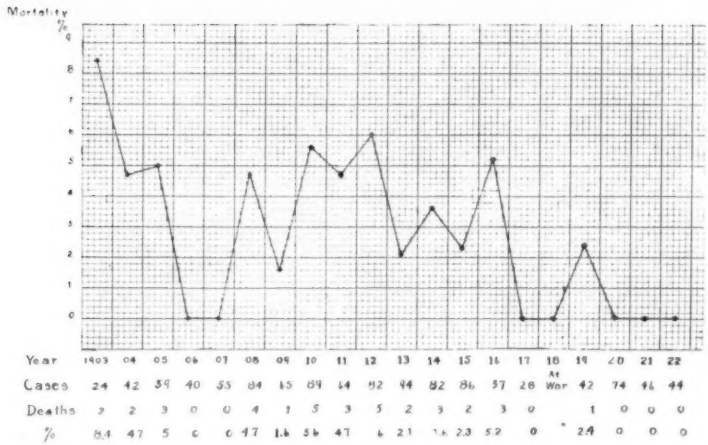

Fig. 14. Chart showing annual mortality rate for the past 20 years, the number of cases operated on each year and the number of deaths among these cases is recorded, and mortality percentage is given on the bottom line. Seven years in which there was no mortality are recorded.

derangement of musculature about the vesical neck or perineum after any form of prostatectomy, may not return to normal for several weeks or months. The bladder is usually contracted and urination on this account more frequent than normal. The weakness of the internal and sometimes of the external sphincter leads to a slight escape of urine on coughing, sneezing or sudden movements, in some cases for several weeks after the operation. By retaining the urine as long as possible in a sitting posture and exercising the sphincter muscles by attempting to cut off the outflow of urine several times during each urination, it is possible in most instances to restore normal urination very promptly; in some cases more prolonged exercise must be undertaken.

Incontinence of urine occurs very rarely. In my 450 cases presented before the International Medical Congress in 1911, there was not a single case of complete incontinence—dribbling night and day. There were three cases of incontinence when the patient was on his feet, and in one of these the operative notes show that the muscular structures in the region of the triangular ligament were injured at operation, and this probably occurred in the other two cases. There were 4 other cases of occasional slight leakage, and cystoscopic examination showed that the prostate had not been completely removed and that an irregularly dilated posterior urethra was present in which urine collected and from which it occasionally escaped.

There is no question but that the fear of incontinence of urine has been responsible for the unpopularity of the perineal route. But this came about as a result of the old-fashioned median perineal incision which passed through the external sphincter and triangular ligament and through which the prostatic lobes were removed piecemeal. It is remarkable that all of these cases were not incontinent, not only on account of the destructive injury of the external sphincter, but on account of the fact that not infrequently deep prostatic lobules were left behind. Ever since my early publications on this subject I have insisted on a careful open operation back of the bulb, transversus perinei muscles, triangular ligament and external sphincter, all of which structures should be seen and carefully avoided, and the urethra opened far back near the apex of the prostate well behind all sphincteric fibers. In an early paper I discussed the use of a long tractor through the urethra or the insertion of a tractor through the bulbous urethra in order to avoid an opening through

TABLE VII.—ANALYTICAL STUDY OF 1049 CONSECUTIVE CASES OF PROSTATECTOMY BY H. H. Y., UP TO OCTOBER 15, 1922

Ages Cases	Residual urine	Preliminary treatment	Preliminary treatment: Duration, adm. to op.	Closure of fistula in 450 cases: Weeks	Closure per cent	Of 450 cases: sexual powers
Under 50 yrs. 16	C.cm. under Cases	Continuous cath., 279	Days Cases 4 85	1	4.5	Answers from 251
50–54 52	50 208	Intermittent cath., 60	5–9 249	2	17	Normal before operation 133
55–59 140	50–99 140	Suprapubic drain, 11	10–14 88	3	30	Erections normal . . . . . 75 per cent
60–64 217	100–199 168	Suprapubic aspiration, 1	14–29 114	4	16	Coitus normal . . . . . 59 per cent
65–70 264	200–299 108		2 mos. 45	5	7	Patients under 60 yrs. . . . . 95 per cent
70–75 213	300–399 41		3 mos. 1	6	5	
75–79 113	400–499 27		4 mos. 3	7	2	Deaths: Among these 1049 consecutive cases by H.H.Y. there were 36 deaths, a mortality of 3.2 per cent. In this series over a period of 20 years there were 7 years in which no deaths occurred.
80–84 28	500–699 41		6 mos. 1	8	2.5	
85–89 2	700–999 21		7 mos. 1	3 mos.	2.8	
90–94 1	1000–1499 . . 20		Less than 4 days 462	Later Incont.	7	
N. I. 3	1500–1999 . . 4			Partial incont.	0	
Total 1049	2000–2600 . . 1				3	
Over 70 years 144	4500 1					
Over 80 years 31	C. R. 158					
	No information 111					

the membranous and prostatic urethra, but the cases in which I tried this showed that the traction obtained was less perfect and the operation lengthened. The use of the long tractor has been continued in operations upon the tuberculous prostate and seminal vesicles, and Dr. Geraghty has recently advised its use in cases of prostatic hypertrophy with the object of completely avoiding the membranous urethra. Time will show whether much is to be gained by this. Cecil has also tried the same scheme with the same object, but I personally believe that if one is careful to see the anatomical structures and particularly to avoid injury to the transversus perinei muscles and triangular ligament (which injury occasionally has happened in my hands from faulty exposure), no difficulty will be experienced in reaching the apex of the prostate and making the incision at a point where no possibility of injury to the external sphincter is present. With this precaution the act of micturition after perineal prostatectomy is distinctly more perfect than after suprapubic prostatectomy because the internal sphincter is usually restored to normal after perineal prostatectomy whereas, after suprapubic prostatectomy, it is usually widely dilated, and as shown by Hyman, Thompson-Walker and others, generally forms a dilated gourd-like neck to the bladder, the urine of which fills the posterior urethra down to the external sphincter. The same thing can be said in regard to rectal fistulæ—they should never occur except in extremely rare instances as a result from suppuration. The rectum has been injured in something less than 1 per cent of the cases, but practically all of them have been cured by the operation published by Stone and myself, which is similar to a procedure of Wildbolz. The injury of the rectum is certainly less common and less dangerous than cutting or tearing into the peritoneum, as in the suprapubic operation, which has a definite mortality of its own.

The general statistics of my 1049 consecutive cases are shown in Table VII.

Summary—Results Obtained in 198 Recent Cases

As an evidence of what might be accomplished by the methods which I have outlined above, I thought it well in closing to bring before you a brief analytical report of 198 consecutive cases in which I have personally operated since my return from France in February, 1919, a period of 3 years and 9 months. During this period there have been 198 cases, and we have had the good fortune to have no fatalities. The analysis of these cases is shown in Tables VIII and IX. These tables need very little explanation. It may be noted that 58 patients, 21 per cent, were over 70 years of age, that the blood pressure was 160 or more in 55 cases, 20 per cent, that the phthalein was below 50 per cent in 93 cases, 45 per cent, the blood urea over

TABLE VIII.—ANALYSIS OF 198 CONSECUTIVE CASES OF PERINEAL PROSTATECTOMY WITHOUT A DEATH—FEBRUARY 8, 1919, TO OCTOBER 15, 1922

Ages		Residual		Blood pressure		Phthalein		Blood urea	
Years	No.	C.cm.	No.	B. P.	No.	Per cent	No.	Grms.	No.
50–54	13	0– 49	40	100–109	5	0– 9	1	1.40–1.49	1
55–59	26	50– 99	31	110–119	12	10–19	2	1.30–1.39	1
60–64	48	100–199	37	120–129	24	20–29	10	1.20–1.29	1
65–69	50	200–299	21	130–139	29	30–39	17	1.10–1.19	1
70–74	40	300–400	11	140–149	41	40–49	36	1.00–1.09	1
75–79	12	500	4	150–159	24	50–59	55	.90– .99	1
80–84	6	600	6	160–169	19	60–69	46	.80– .89	1
No information	1	900	1	170–179	15	70–79	14	.70– .79	3
		1000	1	180–189	10	80–89	2	.60– .69	2
		1200	2	190–199	6	90–99	1	.50– .59	3
		1800	1	200–209	2	No information.	12	.40– .49	10
		Compl. R. U.	12	210–219	3			.30– .39	16
		No information.	29	No information.	6			.20– .29	20
								.10– .19	6
								.01– .09	1

TABLE IX.—ANALYSIS OF 198 CONSECUTIVE CASES OF PERINEAL PROSTATECTOMY WITHOUT A DEATH—FEBRUARY 8, 1919, TO OCTOBER 15, 1922

Heart		Discharge		Fistula closure		Result on discharge	
No.	Cases	Days	No.	Days	No.		
Enlarged	34	10–14	5	5– 9	2	Well	165
Murmur	30	15–19	12	10–14	10	Improved	25
Enl. and Mur.	16	20–24	40	15–19	53	No information.	6
Myocarditis	16	25–29	32	20–29	54		
		30–39	56	30–39	19	Ultimate results	
Preliminary treatment	No.	40–49	22	40–49	6	Cured	129
None	52	50–59	9	50–59	8	Improved	10
Catheter continuous	100	60–69	8	75–79	1	Not improved.	1
Intermittent	6	70–79	1	100–104	1	No information	56
Suprapubic	4	Over 90	6	Average 24 days		Deaths after 6 mos.	8
No information	34	No information.	1			Deaths before 6 mos.	2

0.50 grams per litre in 15 cases, 8 per cent, and some form of heart disease in 96 cases, 49 per cent. Preparatory treatment with a catheter was carried out in over 60 per cent of the cases, but suprapubic drainage was employed in only 4, or 2 per cent, of the patients. The average length of stay in the hospital was 32 days, and the average duration of the fistula 24 days, 14 per cent being open on discharge. As the cases are recent the ultimate result is incomplete, and the 56 cases on which no information is cited are mostly recent cases. The fact that 198 consecutive cases, many of which were very old, feeble patients with markedly impaired kidneys and heart, can be carried through perineal prostatectomy without a death shows very effectively the benignity of this operation.

Discussion

By ALEXANDER RANDALL, M.D., Philadelphia

It is extremely difficult for me to discuss in any critical way the work of Dr. Young, recognizing in him the pioneer in investigating and solving so many of the problems of modern urologic surgery. Certain it is that a long day will pass before the remarkable recovery record which he has reported to you tonight will be equalled.

It is always pleasant to talk of the success of prostatic surgery, returning benefits of a most gratifying nature, in patients least likely to endure an operative procedure. The percentage of successes today is fortunately high, and we have lived to see a mortality rate that was shocking reduced to a nation-wide average of about 10 per cent: ninety successes and ten failures. From this point on I believe a further reduction will be gained more readily by a close analysis of the failures, than by a greater perseverance in the methods that have been productive of this success. Moreover, we *must* add to the 10 per cent of failures (actual mortality) another equal percentage where recovery took place perhaps, but only a partial return of normal function followed. To be fair we must all recognize that such are also surgical failures, and are apt to be errors of an operative technical character that have left us a living patient, to be sure, but one with a urinary frequency, or a persistent residual urine, a persistent fistula, or even a return to catheter life.

It is this group presenting a morbidity, to which I wish to draw your attention this evening, feeling that with the splendid progress made in the past two decades in the reduction of actual mortality, we should now bend our efforts toward the complete eradication of those disagreeable sequelæ which cause prostatectomy to have this postoperative morbidity.

First of all, let me consider from a different angle than the usual, the long mooted question of the choice between suprapubic and perineal prostatectomy.

My studies have convinced me that the prostate, in hypertrophying, shows a predilection for one of two fixed ways of enlarging, and in this difference the internal sphincter plays a very

important rôle. Hedged about by fixed anatomical structures, an enlarging gland must ultimately grow upward. In doing so, the most frequent path of growth is by a gradual dilatation of the internal sphincter and a gradual herniation of the hypertrophying prostate through it into the bladder cavity. The second mode of enlarging is likewise upward, but in this type of case, the internal sphincter remains tonically closed and the prostate, in hypertrophying, raises it and the entire bladder mass without dilating the sphincter at all, it never becoming anything more than a hypertrophied gland remaining within its anatomical limits.

It can be quickly seen that this difference as to whether or not the internal sphincter is dilated, creates a preference as to whether the prostate be removed by the suprapubic or the perineal operation. I consider the careful preservation of the internal sphincter, with its return to normal function postoperatively an essential to a perfect operative result.

Following these two types to their proper surgical handling, it is easily seen that in the first the whole growth has *gradually* dilated the internal sphincter. The surgical indication here is to remove that growth by suprapubic prostatectomy, and in doing so, the dilated sphincter will neither be in the way, nor will it be injured by such enucleation. Following such an operation, it may be expected that the internal sphincter would regain its tonicity and return to function.

In the second type, however, it would be impossible to enucleate such a prostate without first dilating the internal sphincter. It is very dubious whether such could be done satisfactorily at the moment of operating, and in doing the enucleation the result must be that such a sphincter is inevitably lacerated. Again it is very questionable whether such a lacerated muscle would ever regain its functional capacity, and this is the type of hypertrophy which should be removed by the perineal operation, in which the sphincter would neither be dilated nor injured and its functioning ability in nowise hampered. Likewise, this is the type where, following perineal prostatectomy, one can feel, after the enucleation of the prostate, a tight ring about one's finger in the vesical orifice; it is also the type occasionally seen where one enjoys the delightful experience of having a perfectly continent patient immediately following removal of perineal drainage tube.

Close cystoscopic study is necessary for a preoperative decision as regards this point of the dilatation of the internal sphincter, and on it should be based the choice of operative approach.

The second point I wish to make relative to the technical performance of prostatectomy concerns the presence or absence of median lobe enlargement. It has been sufficiently proven, by various investigators in the past, that there is no longer any question as regards the pathological development of a middle lobe of the prostate. When such is present, dilatation of the sphincter is always the case, and suprapubic prostatectomy is the operation of choice. The one particular point that I wish to make is the possibility, and it is a frequent one, of the middle lobe being the sole obstructing feature, and in the total absence of lateral lobe enlargement. In such a case, the usual stigmata of prostatic hypertrophy obtained by rectal examination are absent and cystoscopy alone will render an accurate diagnosis.

One must constantly keep in mind the possibility of such solitary median lobes, wherein the clinical history and the catheter examination suggests prostatic obstruction, but where rectal examination reveals a prostate in nowise above normal in size.

The third technical error that I wish to discuss with you is the proper handling of that condition spoken of as "contracture of the vesical neck," "sclerosis of the internal sphincter," or as "median bar formation." Parenthetically, let it be said that this pathological condition gives a clinical picture identical with that of hypertrophy. Examination likewise reveals a varying amount of residual urine, while generally a small, even atrophic, prostate is felt on rectal examination.

We have all heard the surgeon remark at operation that he unfortunately was dealing with a small sclerotic prostate. Today I would deem such a gross error of surgical diagnosis, and an even worse error of surgical operative technique. Such prostates cannot be enucleated; the process is one due to inflammation and not hypertrophy. Its proper surgical handling requires the removal of the obstruction due to the sclerosed posterior vesical lip. The choice of method by which such should be done varies with the judgment of the surgeon. Such tissue may be destroyed by fulguration; by urethroscopic punch operation (aided or not with the cautery); or by suprapubic cystotomy and excision of a wedge of tissue from posterior lip of vesical orifice.

These are, therefore, three salient points of an operative technical character that I feel are frequent errors of judgment, and are no doubt likewise frequent reasons for an incomplete recovery following prostatectomy, and the cause of a postoperative morbidity that should not exist.

By JOHN H. CUNNINGHAM, M.D., Boston

Dr. Young's brilliant results as regards mortality in connection with prostatectomy in his series of cases, is evidence of what may be accomplished in this malady, which is all the more gratifying when one realizes that the majority of these patients upon whom he has operated are in the period of physical decline.

It is due to Dr. Young, perhaps more than to any other individual in the history of genito-urinary surgery, that prostatectomy may be ranked among the operative procedures carrying a relatively low mortality.

Some 20 years ago when I first became interested in prostatic surgery, the mortality was in the vicinity of 20 or 30 per cent, the patients dying rarely of hæmorrhage, occasionally from sepsis, and most frequently from uræmia. About that time Dr. Young began to show a far better mortality record than was being attained by other noted operators, and I became interested to learn, if possible, what Dr. Young had as a protective measure that the other operators did not possess.

Associating myself with him for a brief time, I discovered his secret. Dr. Young had appreciated that associated with prostatic obstruction was a resulting residual urine, that there was impairment of renal activity and efficiency, and he was correct in his interpretation that improvement in this kidney condition took place by constant drainage of the bladder to relieve kidney back pressure and infection, and forcing of fluids to dilute and produce a greater elimination of the toxines resulting from renal impairment and sepsis.

It was the appreciation of these features, then as now, which are the important features upon which the success of prostatic surgery depends. As Dr. Young has stated, he prefers to secure this adjustment by bladder drainage with the catheter passed through the urethra rather than by suprapubic drainage. I am surprised, however, at the small number of patients in his series requiring suprapubic drainage. Personally I agree with Dr. Young that urethral drainage with the indwelling catheter is the method of choice, and that suprapubic drainage, as a preliminary step to prostatectomy, is the procedure of necessity only.

The essential feature, however, to make prostatectomy safe by either the suprapubic or perineal route, depends upon bladder drainage over a sufficient time to establish the maximum renal efficiency, and the saturation of the patient with fluids to diminish toxæmia to the minimum.

Today we can judge of the kidney value by renal function tests and blood chemistry. As Dr. Young has just shown, there has been an increase in the phenosulphophthalein output and a diminution of the nitrogen retention in the blood, dependent upon bladder drainage and forced fluids.

Experience has shown that there is a certain standardization in regard to kidney elimination and nitrogen retention in the blood which, being attained, gives assurance in regard to the safety of the operative procedure of prostatectomy. An attempt should be made to bring about such a standardization before prostatectomy is undertaken.

Dr. Young's series deals entirely with the perineal dissecting operation, an operation which can only be properly executed by one who has a special knowledge of the technique, and for that reason the operation, in the hands of good surgeons, but without the special knowledge required, has resulted in operative difficulties and unfortunate sequelæ, so that the operation has not been given the general recognition which it justly deserves.

It is natural that the surgeon accepts suprapubic prostatectomy in preference to the dissecting perineal operation because of its lesser technical requirements. It may not be realized, however, that suprapubic prostatectomy carries a mortality at least twice as high as that of the perineal route.

Personally I think the whole subject of perineal versus suprapubic prostatectomy may be summarized in a general way by the statement that suprapubic prostatectomy carries twice the mortality, but in the hands of most, there may be expected a better average functional result.

The best manner of dealing with malignant tumors of the bladder is one of the unsettled problems of genito-urinary surgery. The technique described by Dr. Squier[1] is, without question, the proper one to be employed in cases where eradication of the disease, by surgery, is to be undertaken.

The essential feature, as Dr. Squier emphasizes, is to free the bladder so completely from its bed that it can be drawn out of the suprapubic wound and the resection of the diseased area carried out, leaving a liberal margin of normal tissue about the growth, dividing the ureter when necessary

[1] J. Bentley Squier. Segmental resection of the bladder for neoplasm. In press.

to accomplish this, and implanting it into a healthy portion of the bladder.

Nothing short of the extensive operation as described by Dr. Squier should be attempted.

There is nothing I can say in connection with the particular type of bladder tumor which Mr. Kidd[1] has described, and which he considers to be the rarest of all tumors found in the urinary bladder, except to emphasize the importance of the careful pathological study of surgical specimens, without which we would not have been favored with this communication.

The study of bladder tumors, during the past twenty years, has been perhaps more clinical than histological, because of the perfection of the cystoscope and development of non-operative therapeutic measures.

As a result, certain visual characteristics determine bladder tumors to be benign or malignant by cystoscopic investigation, and since the introduction of fulguration by Beer in 1910, most benign tumors have been subjected to such treatment rather than operation, and particularly during the past few years the employment of radium further reduces the number of tumors removed surgically, and the opportunity for pathological study is therefore less frequent, especially in benign tumors, so that the rarer types may be even less frequently recognized.

I cannot refrain from adding, however, that I strongly feel that malignant or questionable malignant bladder tumors require extensive resection, and it will be this, quite largely, from which we may obtain further histological information.

Mr. Fullerton's admirable contribution[2] showing so conclusively that a kidney, affected by disease, may be expected to secrete a urine of relatively low specific gravity, is a very important fact. The realization that the specific gravity of a urine secreted from a diseased kidney will be lower than from a normal kidney, taken together with the other information obtained by simultaneous collection of the urine from each kidney, by ureter catheterization, gives us an additional diagnostic feature in determining the relative renal values. Like so many clinically established facts in medicine, the explanation may remain in debate, as Mr. Fullerton's remarks indicate in this instance. It is, however, the clinical facts which concern us primarily as clinicians and surgeons, and Mr. Fullerton's observation deserves most sincere appreciation.

[1] Angiomyoma of the urinary bladder. Surg., Gynec. & Obst., 1923, xxxvi, 467.

[2] Unilateral diuresis. Surg., Gynec. & Obst., 1923, xxxvi, 16.

STOFFEL OPERATION FOR SPASTIC PARALYSIS

With Report of Twenty-four Cases

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THE object of this paper is to present a preliminary report on the results obtained in spastic paralysis by means of the Stoffel operation. Fifty-nine operations were done in 24 cases. Although a sufficient length of time has not elapsed for a final report, the results as a whole, particularly in certain types as compared to other commonly used methods, are so encouraging as to warrant the belief that they will be permanent, and even grow better as time passes.

The tendency is prevalent to consider treatment hopeless, or that the results obtained over an extended period of treatment do not show sufficient improvement to justify the effort, particularly since a large number of these patients are more or less mentally defective. This may vary from the completely normal mind to that of the hopeless idiot. Deficient mentality of whatever grade is no excuse for declining treatment, if there can be any expectation of making the child better able to care for itself and thus relieve the parents of a great load. However, a great proportion of these patients are not idiots, and, if we can enable them to walk, or relieve them of disabling and conspicuous contractures, they will become less a burden, and may become more useful members of society. Again, a decided improvement in the mentality is frequently noted in those mentally defective patients in whom contractures have been relieved, thus allowing better muscle co-ordination and balance. It is probable that education in co-ordination is a stimulant to the higher centers. Whatever the explanation, surprisingly rapid improvement often occurs.

There are four clinical types, and the degree of mental involvement, as a rule, is directly in proportion to the extent of the spasticity. In the order of their frequency they are—

1. Spastic diplegia, or involvement of both the upper and lower extremities. In this class the most marked mental impairment is usually seen;

2. Spastic paraplegia, or involvement of only the lower extremities. The average mentality is better than in Class 1;

3. Spastic hemiplegia. Here the central lesion is on one side only, and is usually of less extent than in bilateral involvement. The mentality is usually good;

4. Spastic monoplegia, or involvement of a single arm or leg. This is relatively rare, for signs of a slight spasticity in the corresponding other extremity may generally be found as evidenced by more active deep reflexes. The central lesion is small and mental impairment is rarely seen.

From an operative standpoint, we are not interested in the etiology as the damage has been done and is irreparable, except in those cases which are the result of increased intracranial pressure for which Sharp does his decompression operation. However, to understand fully the nature of the process with which we are concerned, a review of the various possible etiological factors may not be amiss. Tubby (1) classifies spastic paralysis as follows:

A. Intra-uterine origin—
1. Large cerebral defects, such as porencephaly, and absence of the gray matter;
2. Hæmorrhage and softening;
3. Microcephaly;
4. Syphilis;
5. Specific fevers;
6. Eclampsia and convulsions;
7. Injuries;
8. Repeated pregnancies.

B. Traumatism during labor.

C. Acquired after birth.
1. Meningeal hæmorrhage, embolism, thrombosis from syphilitic arteries and in association with marasmic conditions; as a result vascular lesions, cysts, softening, atrophy and sclerosis;

2. Chronic meningitis;
3. Hydrocephalus;
4. Primary encephalitis (Struempell).

The aim of treatment is to develop voluntary control and co-ordination of muscles. In the milder cases where no contractures are present and the patient possesses a good grade of intelligence, this can be accomplished by a system of muscle training and massage which can only be carried out by one who has been especially trained for such work, and who has unlimited patience over painstaking details. Contractures must be relieved before restoration of muscle balance can be accomplished. The procedures that have been employed are:

1. Tenotomies;
2. Tendon transplantations;
3. Resection of the posterior nerve roots of the spinal cord (Foerster's operation, 2);
4. Cranial decompression (Sharp and Farrell, 3);
5. Temporary paralysis by alcohol injection of nerves (Allison and Schwab, 4);
6. Intra-perineural neurotomy (Nutt, 5);
7. Partial resection of motor nerves (Stoffel, 6).

The problem may be attacked at any point in the reflex arc as sensory nerve, motor nerve, muscle, or toward removing the cause of the lesion itself as intimated above in the decompression operation. Tenotomies and tendon transplantations, which have been used for years and which still have their places, are directed toward the muscle. Tenotomy is used most successfully when applied to the Achilles tendon, hamstrings, and adductors; tendon transplantation, by transplanting either the outer or inner hamstrings, preferably the biceps, and Tubby's operation of transplanting the pronator radii teres.

Relapse has been the rule in our experience with simple tenotomy in any except the mild cases, and in these there is no actual shortening as demonstrated by full relaxation under general anæsthesia. Three cases, 1, 20, 21, had had tenotomies previously, but all relapsed within a year. The necessary mental co-operation and application of effort required after tendon transplantation makes this operation useful only in those patients who have a good mentality. A spastic muscle transplanted still remains spastic.

Resection of the posterior nerve roots means a laminectomy. The mortality is high, 7 to 15 per cent, and the operation is difficult technically. The convalescence is long. Sensory, rectal and bladder disturbances are troublesome. It is applicable only to the severest generalized types.

Cranial decompression is limited to those cases in which the spasticity is due to an increased intracranial pressure, and is, therefore, not indicated in a majority of cases. One would hardly recommend decompression in one of the less severe cases in which the mentality is good, and in which the spasticity is not generalized.

I have had no experience or have made no observations with the alcohol injection of the peripheral nerves or with the intraperineural neurotomy. The objection that occurs is that the results of these procedures are only temporary.

The Stoffel operation appeals because of—

1. Its simplicity;
2. The exact dosage is possible;
3. There is less likelihood of a recurrence of the contracture;
4. There is no resulting disturbance of sensation.

In 1910, Stoffel demonstrated that the peripheral nerves have a cable-like structure or nerve pattern, and that the funiculi or nerve bundles making up the nerve always bear the same relation to one another. Each bundle supplies motor fibers to a very definite portion of muscle. The muscle is made up of several parts and the energy produced is the aggregate of these parts. To lessen the aggregate we need only reduce the number of the parts. To isolate the parts, the terminal motor nerves can be divided as they enter the muscle. This is impracticable in some locations as in the large group of muscles in the forearm, while it is possible in others as the gastrocnemius, where the branch breaks up into its several bundles in an easily accessible place before they enter the muscle. With a knowledge of the anatomical relations within the main nerve trunk this can be exposed anywhere along its course, the bundles

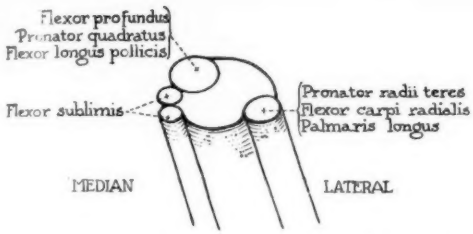

Fig. 1. Topography of the cross-section of the median nerve. Diagrammatic.

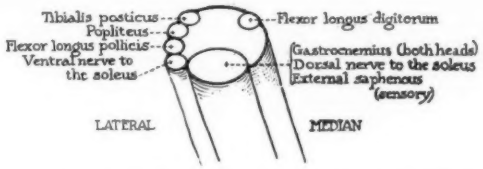

Fig. 2. Topography of the cross-section of the internal popliteal nerve. Diagrammatic.

isolated, stimulated with an electric current as a check, and a portion resected. Those parts of the muscle supplied by the resected bundle become paralytic; the others remain spastic as before. The muscle is weakened, and, theoretically, if the correct number of nerve fibers is resected, equilibrium is restored. Needless to say one must be familiar with the nerve pattern before operation is attempted, and plan the operation from a study of the degree of spasticity present. The opinion of just what bundles to resect, and how much of them to resect, is based only on past experience. Variations in the internal topography of the nerve are so slight that once this knowledge is obtained the electrical current may be dispensed with, but held in reserve for a possible case of doubt.

We have operated on the median, sciatic, obturator, and internal popliteal nerves. For the technique of the operation I would refer the reader to the excellent drawings in Vulpius and Stoffel, the description by Stoffel in the *American Journal of Orthopedic Surgery*, May, 1913, x, No. 4, and by Gill in the *Journal of Orthopedic Surgery*, February, 1921.

For the pronation contracture of the forearm and the flexion contracture of the wrist, fingers, and thumb, the median nerve is exposed just above the bend of the elbow. About 2 inches of the bundle supplying the pronator radii teres, flexor carpi radialis, and the palmaris longus are resected. We usually resect the entire nerve supply to the flexor sublimis digitorum muscle leaving the flexion of the fingers to be performed by the profundus which is inserted into the distal phalanx. One-third to one-half of the nerve supply to the flexor longus pollicis is resected, depending on the severity of the spasticity of the thumb. We have had no case in which it was found necessary to resect a portion of the bundles to the profundus muscle, although this may be necessary in the most severe cases. The medial half of this muscle inserting into the ring and little fingers is supplied by the ulnar nerve, and, of course, these bundles would be resected by operating on the ulnar. As in contractures in the lower extremities I believe it is best to err on the safe side, doing too little rather than too much, as more can be done at a later operation if necessary. It takes only a short time, is easily done, and there is a minimum handling of tissues entailing no shock.

For spastic adductors of the thighs, the obturator nerve is exposed by an incision from the pubic spine extending downward along the adductor longus tendon. No difficulty has been found in obtaining a good exposure of both branches of the nerve through this incision. The adductor longus tendon is retracted outward exposing the anterior branch. The posterior branch is readily exposed under the adductor brevis by retracting this muscle outward and upward. This method of exposure of the posterior branch obviously is easier than following the anterior branch up to the obturator foramen. The anterior branch supplies the gracilis, the adductor longus, and adductor brevis muscles. In moderately severe cases resection of the anterior branch is sufficient, but in more severe cases both the anterior and posterior branches are resected. In two cases in which only the anterior branch was resected it was found necessary later to resect the posterior branch in addition. The posterior branch supplies the obturator externus, the adductor magnus, and sometimes the adductor brevis

muscles. The adductor magnus receives a double nerve supply; those fibers arising from the pubic arch are supplied by the obturator, while that part arising from the ischial tuberosity are supplied by the sciatic. The pectineus and hamstrings, supplied by the anterior crural, also aid in adduction. Thus, when both branches of the obturator are resected, there still remains a considerable degree of voluntary adduction.

To relieve spasticity of the hamstrings, the sciatic nerve is exposed by an incision beginning at the gluteal fold and running downward. For moderately severe contractures the bundle supplying the long head of the biceps and that supplying the semimembranosis are resected. In severe cases, approximately one-third of the bundle to the semitendinosis is also resected. Therefore, there remain intact on the lateral side the short head of the biceps and either all or a part of the semitendinosis on the inner side. These two spastic muscles are sufficient to maintain active flexion of the knee, but their united energy is not sufficient to overcome the extensors of the leg.

To overcome spastic equinus, the internal popliteal nerve is exposed in the popliteal space. It is the most superficial structure in the popliteal space, and the artery and vein are not seen. In moderately severe cases we resect the bundles to the outer and inner heads of the gastrocnemius; in more severe cases one-half of the dorsal nerve to the soleus is also excised. In very severe cases this entire bundle is resected leaving plantar flexion of the foot to be performed by the ventral portion of the soleus, the tibialis posticus, and the flexor longus muscles to the toes. In none of these cases has it been found necessary to weaken the flexor longus digitorum because of a varus.

Spastic contractures disappear under deep anæsthesia, while atrophic contractures do not. If it is found at the time of operation that the contracture persists, we know that structural shortening exists, and it is necessary to lengthen the tendon. This was found necessary in four cases of a severe atrophic contracture in which the foot could not be dorsiflexed to a right angle.

Immediately after operation the extremity is fixed in overcorrection, stretching the spastic muscles and relaxing the antagonists. In pronation contracture of the forearm, the cast is applied in complete supination; the contracted fingers, thumb, and wrist are held in hyperextension. It is frequently surprising to note the increased amount of power developed in the antagonists after relaxation for 4 weeks. After operation on the obturators, the thighs are held in extreme abduction; similarly, the knees in extension, and the feet in dorsal flexion. The casts are removed at the end of 2 to 6 weeks depending on the degree of weakness of the antagonistic muscles, and massage and muscle training are received. The patient is immediately encouraged to walk without apparatus. Our experience is that of Gill (7) in regard to the after-care of the upper extremity. It has been found necessary to hold the forearm and fingers in overcorrection for a much longer time than the lower extremity. The cast is bivalved and the posterior half removed in order that the hand may be removed frequently for treatments. The length of time this splint is continued varies with the progress of the individual case. The mere act of walking, or being able to stand with no contractures does not require the extraordinary degree of co-ordination necessary in the complex use of the hand. For that reason, I believe, the results are not so uniformly good in the upper extremity as in the lower. The pronator contracture is readily overcome and good functional results are obtained in active pronation and supination, but in comparison the results obtained in the complicated use of the fingers and thumb are not so good.

The operation is most suitable in those spastic contractures which are localized in definite muscle groups. It is not indicated in cases showing a diffuse spasm of the whole extremity as in the severest cases of Little's disease. In these cases the Foerster operation as advocated by Blahd and Stern (8), or perhaps the decompression operation of Sharp, may be worth while. There is no indication for its use in athetosis, and, of course, should not be used in any progressive disease. It is contra-indicated in the hopeless idiot who

Fig. 3.

Fig. 4.

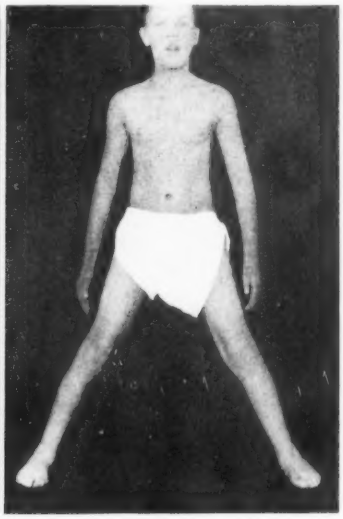

Fig. 5.

Fig. 3. Case 4. Showing result after a spastic equinus.
Fig. 4. Case 6. Showing result after a spastic equinus.

Fig. 5. Case 7. Result after operation on the obturator and internal popliteals.

would never be able to walk even though contractures were relieved. At least a fairly good degree of intelligence should be had in order to obtain a good result in the upper extremity, for reasons mentioned above.

CONCLUSIONS

From the results obtained by the Stoffel operation in 24 cases, I believe the spastic contractures of the adductors and spastic equinus can be absolutely relieved. We have operated on only two cases of contracture of the hamstrings, and the number is not sufficient to draw conclusions on these. However, in one of these recurrence had occurred after tenotomies, and, at present, one year after the Stoffel operation, there is no tendency toward contracture. While spastic contracture of the fingers and thumb can be relieved, the ultimate function of the hand is not so encouraging as in the lower extremity. Perhaps a sufficient length of time has not elapsed in these cases to obtain the maximum result. This, I believe, is not the fault of the operation itself, but is due to the nature of the extreme complexity of motions required in the normal hand.

CASE REPORTS

CASE 1. M. S., age 13. Spastic paraplegia. Could not stand without support. Severe contracture of the adductors and hamstrings. Subcutaneous tenotomy of the adductors and open tenotomy of the hamstrings were done on July 12, 1921. She returned the following December with the contractures as before. Stoffel operation was done on both sciatic nerves on December 14, 1921. The next day it was observed that the knees could voluntarily be completely extended, and there was no spasticity of the hamstrings. Stoffel operation on the anterior branch of both obturators was done on May 10, 1922.

This patient was last seen in November, 1922, and had an almost complete range of voluntary abduction of both thighs, and complete extension of both knees. She was able to stand and walk a short distance with no support, and fairly well with braces applied because of weak quadriceps. A letter from the father says he is "well pleased." Result good.

CASE 2. C. L., age 8. Spastic hemiplegia. Moderately severe spastic equinus and slight contracture of the forearm in pronation. Transplantation of the pronator radii teres on January 25, 1922, and Stoffel operation on the internal popliteal on February 22, 1922. The nerves to both heads of the gastrocnemius were resected. He was last examined in July, 1922, when the foot could be actively dorsiflexed beyond a right angle. There was only a very slight limp. Result excellent.

Fig. 6. Case 9. Result after operation on the median nerve for contracture of the forearm, wrist, and fingers.

CASE 3. G. S., age 14. Spastic hemiplegia. There was a very severe spastic equinus, and only slight power in the extensors of the toes. Stoffel operation was done on February 22, 1922, when the nerves to both heads of the gastrocnemius together with one-half of the dorsal nerve to the soleus were resected. Under deep anæsthesia the foot could not be dorsiflexed to a right angle. A tenotomy of the Achilles tendon was done.

This patient now walks flat on the sole and has good active dorsiflexion. Result excellent.

CASE 4. Z. L., age 4. Spastic hemiplegia. Disability in the arm slight. Has been receiving physiotherapy for 2 years. Walked on toes, and foot could not be dorsiflexed to a right angle. On February 25, 1922, the nerves to both heads of the gastrocnemius were resected. This child is still under observation, and on studying her gait it is impossible to tell which side was operated on. Result excellent.

CASE 5. D. T., age 4. Spastic hemiplegia. Had been receiving physiotherapy for 1 year. Very severe spastic equinus. On February 28, 1922, the nerves to both heads of the gastrocnemius and one-half of the dorsal nerve to the soleus were resected. The Achilles tendon was lengthened subcutaneously. She now walks flat on the sole and has only a very slight limp. Result excellent.

CASE 6. K. N., age 4. Spastic hemiplegia. Had been receiving physiotheraphy 18 months. Walked on toes, and heel could not be made to touch the floor. Stoffel operation on February 28, 1922, when the nerves to both heads of the gastrocnemius were resected. This child is still under observation. There is only the slightest perceptible limp. The foot can be dorsiflexed beyond a right angle. Result excellent.

CASE 7. G. M., age 12. Spastic paraplegia. Walked high up on the toes and with the knees in close apposition. On March 1, 1922, the nerves to both heads of the gastrocnemius and one-half of the dorsal nerve to the soleus were resected on both sides. On May 22 the anterior branch of each obturator nerve was resected. When last examined, in August, 1922, he walked flat on the soles, and had an almost complete range of voluntary abduction of the thighs. Result excellent.

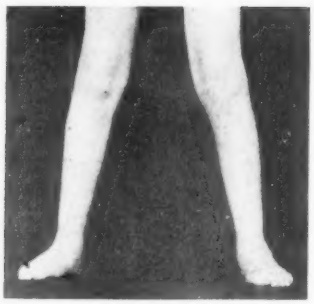

Fig. 7. Case 10. Result after operation on the obturators and internal popliteals.

CASE 8. H. S., age 21. Spastic hemiplegia resulting from an acute endocarditis in 1918. There was a very severe spastic contracture of the forearm in pronation, and flexion contracture of the wrist, fingers, and thumb. Stoffel operation on the median nerve on March 14, 1922. The bundle to the pronator radii teres, flexor carpi radialis and the palmaris longus, and the bundles to the flexor sublimis digitorum were excised. He was last examined in September, 1922, and had complete relief of the pronation contracture. The function of the fingers was decidedly improved. Result fair.

CASE 9. S. T., age 13. Spastic monoplegia. There was a very severe spastic contracture of the forearm, wrist, and fingers. Stoffel operation on the median nerve on March 8, 1922. He was last examined in September, 1922, and had complete range of voluntary supination and almost complete extension of the fingers. There was good active power in flexion of the fingers. Result excellent.

CASE 10. G. S., age 9. Spastic paraplegia. Walked on toes and had a tendency to cross his knees. Stoffel operation on the anterior branch of both obturators on May 31, and on both internal popliteals on June 28, 1922. He is now able to walk flat on the soles and can keep his knees well separated. Result excellent.

CASE 11. E. S., age 6. Spastic paraplegia. There was a rather severe bilateral equinus. Stoffel operation on both internal popliteal nerves on June 8, 1922. The nerves to both heads of the gastrocnemius and one-third of the dorsal nerve to the soleus were resected. A letter from the father in November states that the child walks flat on the soles and that he considers the operation very successful. Result excellent.

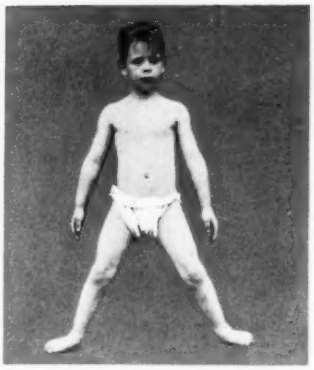

Fig. 8. Case 12 Result after operation on the obturator and internal popliteals.

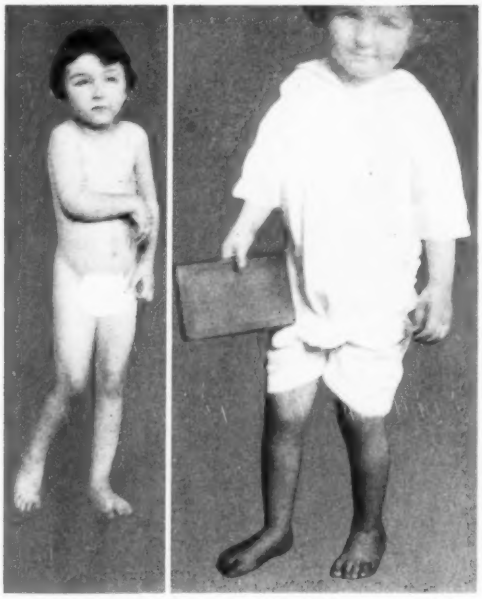

Fig. 9 (at left). Case 17. Spastic hemiplegia before operation. The position of the hand, forearm, and foot are typical.

Fig. 10. Case 17. After operation. The heel is on the floor. The forearm is midway between pronation and supination, and the ability to grasp objects is shown by her holding a book.

CASE 12. B. E., age 7. Hereditary spastic paraplegia. This child, examined with his brother, Case 13, had a very severe spastic contracture of the calf muscles and adductors. The condition in both children had been noted soon after birth. The mother and grandmother were present at the examination and it was observed that both had spastic contractures of the calf muscles. Stoffel operation on the anterior branch of both obturator nerves on July 26, 1922, and the nerves to both heads of the gastrocnemii on June 14, 1922. He was examined on December 6, 1922, and had practically no disability in walking. Result excellent.

CASE 13. S. E., age 9. Hereditary spastic paraplegia. Brother of Case 12. Very severe spastic contracture of the adductors and calf muscles. When he was 3 years of age he received an extensive burn over the left popliteal space, and the contracted scar did not permit extension of the knee beyond 135 degrees. Scar excision and Stoffel operation on the internal popliteals on June 14, and resection on the anterior branch of the obturators on July 26, 1922. A very good result was obtained in the relief of the spastic calf muscles, but there still remained difficulty in abducting the thighs. Accordingly, on October 11, 1922, the posterior branches of the obturators were resected. He was last examined on December 6, 1922, and while the spastic contractures had been relieved, he could not walk as well as his brother. Result good.

CASE 14. H. C., age 8. Spastic hemiplegia. Stoffel operation on the internal popliteal on June 24, 1922. There was a severe atrophic contracture of the Achilles tendon, and this was tenotomized. A transplantation of the pronator radii teres was done on July 12. She was last examined in November, 1922, and had an excellent result.

CASE 15. L. L., age 3. Spastic paraplegia. Child had never walked and was unable to stand alone. When supported he stood high up on the toes and crossed his knees. Stoffel operation on the anterior branch of both obturators and the nerves to both heads of the gastrocnemii on July 11, 1922. Six weeks after operation the child was able to walk across the room with no support and there appeared to be absolutely no evidence of spasticity of the muscles operated on. Result excellent.

CASE 16. J. B., age 3. Spastic paraplegia. Had never walked or stood alone. When supported stood high up on his toes and crossed his knees. Stoffel operation on the anterior branch of the right obturator and on both the anterior and posterior branches of the left obturator on July 15, 1922. Nerves to both heads of the gastrocnemii were resected at the same operation. While the spasticity is relieved, the child is not yet able to take more than a few steps alone. When he is led there is no tendency to walk on his toes or cross his knees. Greater abduction is possible in the left thigh. Result good.

CASE 17. P. J., age 3. Spastic hemiplegia. Did not walk until 26 months of age. Moderately severe contracture of the calf muscles, and of the forearm, wrist, and fingers. Stoffel operation on the median and internal popliteal nerves on July 25, 1922. This child was last examined in September, 1922. A very good result in the leg had been obtained. The pronation spasticity was almost completely relieved

and there was a marked improvement in the use of the fingers. Result good.

CASE 18. C. C., age 7. Spastic hemiplegia. There was a most severe contracture of the forearm and hand. Only slight disability in the leg. At operation on August 24, 1922, the median nerve was found to be atrophic and only about one-half the normal diameter. The bundle to the pronator radii teres was identified and resected without difficulty; but even with the aid of electrical stimulation the other bundles could not be satisfactorily isolated. This child is still under observation and has little remaining spasticity of the pronators. There has been no improvement in the use of the hand. Result poor.

CASE 19. H. L., age 9. Spastic hemiplegia. Most severe contracture of the forearm and hand. Stoffel operation on September 21, 1922. The bundle to the pronator radii teres, flexor carpi radialis and palmaris longus was resected together with those to the flexor sublimis digitorum. This child is still under observation, and here again we have practically complete relief of the pronation contracture. She is able almost completely to extend the fingers and has a fairly good grip. With further muscle training a very useful hand is expected. Result good.

CASE 20. L. M., age 14. Spastic hemiplegia. Most severe contracture of the forearm in pronation and the fingers and wrist in flexion. The heel could not be brought closer than 5 inches from the floor. She had had two tenotomies of the Achilles tendon done previously at another hospital, but they were unable to prevent the contracture from recurring. Stoffel operation on the median and internal popliteal nerves on September 21, 1922. Even after a tenotomy on the Achilles tendon the foot could not be brought to a right angle. After operation an apparatus gradually to force the foot in dorsal flexion was applied. She is still under observation and is able to walk flat on the sole. The spasticity of the pronators has been relieved, and there is a marked improvement in the use of the hand. She will improve still more with muscle training and massage. Result on leg is good; that on hand is fair.

CASE 21. L. T., age 20. Spastic paraplegia. Had tenotomies of the adductors and Achilles tendons 1 year before. The contractures returned and she walked with great difficulty high up on the toes, crossing the knees. Stoffel operation on November 22, 1922. Both branches of both obturator nerves were resected; also the nerves to both heads of the gastrocnemii and one-half of the dorsal nerve to the solei. Only 6 weeks have elapsed since operation, but there is every indication of a satisfactory result.

CASE 22. M. C., age 16. Spastic paraplegia. Difficulty in walking because of moderately severe spastic adductors and calf muscles. Stoffel operation on Nobember 11, 1922. Resection of the anterior branch of both obturators, nerves to both heads of the gastrocnemii, and one-half of the dorsal nerve to the solei. A sufficient length of time has not elapsed to report on the result.

CASE 23. G. C., age 3. Spastic paraplegia. Had never walked or stood alone. Stoffel operation on the obturators and internal popliteals on December 11, 1922.

CASE 24. H. B., age 4. Spastic paraplegia. Had never walked. Stoffel operation on the obturators and internal popliteals on December 13, 1922.

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ANALYSIS OF MY END-RESULTS IN THYROID SURGERY[1]

By CHARLES A. PORTER, M.D., F.A.C.S., Boston

THIS series commenced in 1904 and includes all of my cases wherever operated upon. I have not analyzed my non-toxic goiters, so will only state that in more than 250 of these cases only one death occurred, a woman of 67, with a very large goiter of 40 years' duration, who died of pneumonia and hæmorrhagic nephritis 3 days later. Some of the operations have, of course, been difficult and bloody, with occasional alarming cyanosis. To my surprise, there has been no severe secondary hæmorrhage. Of the important complication, injuries to the recurrent nerves, I shall speak later. As is well known, it is most important to examine the larynx before operation, as a previous injury to one nerve may determine extra care in preserving the one on the other side. Many patients are hoarse for a varying time after operation, and in a few weeks or months recover a practically normal voice. This is no proof whatever that a nerve injury has not occurred, for it is the rule that the other cord compensates the function. *Nothing excludes a nerve injury but a thorough examination of the larynx.*

More frequently there have been a few cases of infection in drained than in undrained wounds, the infection varying from bloody serum under the line of incision to definite infection, sometimes developing 2 weeks or a month after discharge from the hospital. Local anæsthesia has seemed somewhat to predispose to such infection, particularly in the slight operation of superior thyroid ligation. Where drainage through the middle of the incision is used and infection occurs, there often results a puckered scar, moving with deglutition. I prefer deep drainage through the ends of the incision, with a small superficial drain, in the midline, outside the sutured prethyroid muscles. The incision must be in the line of cleavage of the skin, and may extend, if more room is needed, far back on both sides, but should never run obliquely or vertically upward, or the scar will spread or become hypertrophied. I prefer fine silk for sutures. Stitches, always loosely tied should be removed on the third or fourth day If in haste, skin clips are useful.

MALIGNANT DISEASE OF THE THYROID

From 1909 to 1920 there were 19 cases; 4 were classified as sarcoma and 15 as carcinoma.

MALIGNANT LYMPHOMA

CASE 1. A case of malignant lymphoma, a woman of 48; duration 1 year, tumor hard; stenosis of the trachea; biopsy report was lymphoma or syphilis. Wassermann negative. October 23, 1911, subtotal thyroidectomy; uninvolved right upper pole was not removed; left abductor paralysis. Pathological report: Malignant lymphoma. The present diagnosis is chronic infectious thyroiditis, infiltrating the muscles. In April, 1922, she is in perfect health; no recurrence; still somewhat hoarse.

MIXED-CELLED SARCOMA—THREE CASES

CASE 2. A woman of 36; 14 years' duration; recent rapid increase suggesting hæmorrhage into a cyst. Operation, December 21, 1912; tumor the size of a baseball, partly cystic and encapsulated, removed; drainage. Pathological report: sarcoma. Home in 2 weeks. Slight hæmorrhages; continued capillary bleeding in spite of packing. Death, February 18, 1913.

CASE 3. A man of 65, duration 2 years; rapid growth for 3 months. Large tumor, fixed; can only speak in a whisper. Operation, January 2, 1913, local and ether. Soft tumors thoroughly removed from both sides of the trachea with left internal jugular vein; actual cautery used. Pathological report: sarcoma, January 3, tracheotomy for dyspnœa. Death, January 11, from purulent bronchitis and exhaustion.

CASE 4. A woman of 54; duration 2 months; two X-ray treatments; severe pain; large, very tender tumor of the left lobe; left recurrent paralysis; some fever. Operation, December 31, 1915, gas and oxygen; left hemithyroidectomy with removal of lymph glands; veins thrombosed; tumor size of a lemon; diagnosis was large, round-celled sarcoma. Wound later showed infection. Death, January 16, 1916.

The remaining 15 cases were all classified as papillary adenocarcinoma or adenocarcinoma.

CASE 5. Man of 25; duration 1 year, gradually increasing bilateral tumor of the thyroid, with glands in the posterior cervical triangles and both

[1] Read before the American Surgical Association, May 2, 1922.

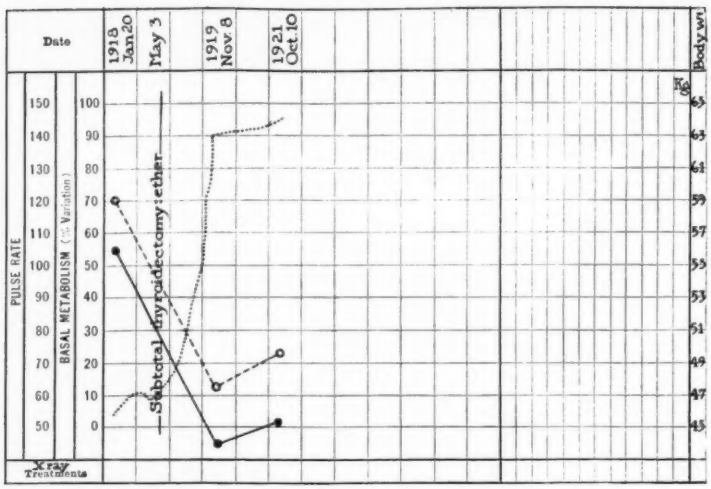

Chart 1. L. T. Female, age, 35. Duration 1 year and 2 months. Graves' disease.

axillæ. Operation, March 11, 1911; much thyroid tissue and many lymph glands removed with the internal jugular vein. Pathological report: adenocarcinoma with necrosis. Discharged in 5 days; wound healed. Readmission, December 29, 1911, for steadily increasing dyspnœa and recurrence of growth; difficult tracheotomy through cancerous tissue. Frequent hæmorrhages; death in 3 months from repeated hæmorrhages and exhaustion.

CASE 6. Man of 65; duration 10 months; for the last 2 months increasing dyspnœa; large mass on the left, adherent to trachea and larynx. Trachea pressed to the right. Operation, July 24, 1913, local anæsthesia. Isthmus isolated with mattress stitches, then incised, and trachea opened. Polypoid mass bobbing up and down in the trachea removed; tracheotomy tube inserted and much of the left lobe of the gland removed. Growth found, however, to encircle the trachea. Two days later, leakage of milk; larger tube inserted followed by two hæmorrhages; controlled by packing. Pathological report: adenocarcinoma. Death in 5 days from purulent bronchitis.

CASE 7. Dentist of 41, operated upon 5 months previously by another surgeon for supposed adenoma of 1 year's duration. This was later reported cancer. Hard mass with glands on the right; persistent sinuses. Operation, August 24, 1918, under novocaine; mass of glands, probably malignant, extending down to the mediastinum, removed. Pathological report: tuberculosis. From August 27 to October 16 was given four X-ray treatments, involvement of œsophagus, obviously by cancer. November 14, 1918, gastrostomy; hæmorrhage from the neck wound; tracheal fistula. Death, November 18. This case was recurrent cancer of the thyroid with tuberculous glands.

It is very doubtful if operations in Cases 6 and 7 were worth while. These two tracheotomies, followed by death, one 5 days and one 3 months after operation, with repeated hæmorrhages, raise the question of the best treatment in such cases. This must depend on the surgeon's and the patient's point of view.

In Case 7 the only hope of cure was lost unless operation had been done immediately upon the change in diagnosis from adenoma to carcinoma. The patient received no benefit from my partial operation, and gastrostomy, done at his request, was too quickly followed by death from hæmorrhage to be worth while.

CASE 8. Codman Hospital. Woman 67; duration 6 years; right lobe increasing in the last month to the size of an orange; dysphagia. Operation, August 24, 1912; growth adherent to the carotid artery and pneumogastric nerve carefully removed with internal jugular; remaining tissues lightly touched with the actual cautery. Would soundly healed in 15 days. Pathology: adenocarcinoma. One week after discharge the growth recurred with frightful rapidity. Death 3 weeks after discharge.

CASE 9. Woman of 44; duration 28 years; rapid increase of growth in the last 8 months, involving the whole left lobe and adjacent lymph glands. Trachea displaced to the right, causing dyspnœa. X-ray examination raised the question of metastasis in the fourth cervical vertebra. Report of biopsy: adenocarcinoma. Operation, September 27,

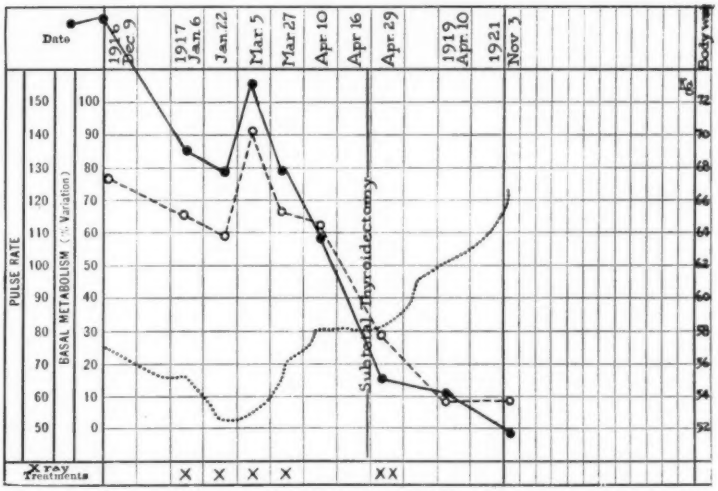

Chart 2. M. M., female, age 21. Duration 1 year. Graves' disease.

1916: whole left lobe and isthmus removed as well as encapsulated mass from the superior mediastinum; radical, clean dissection. Discharged; wound healed in 3 weeks. Died three weeks later.

Neither Case 8 nor case 9 lived long enough to justify such radical and difficult operations.

CASE 10. Woman of 50; recent rapid growth of tumor of the left lobe which had been present for 7 years; no hoarseness; some dyspnœa; growth intimately adherent to the tracheal rings. Operation, November 16, 1911; tumor removed with the internal jugular and œsophageal muscles down to the mucosa. Œsophageal muscles sutured with catgut. Discharged, healed, in 2 weeks. Recurrence at the end of 1 year. In this case the operation was certainly justified. Date of death unknown.

CASE 11. Woman of 52; Dr. Sheehan, Worcester Hospital; duration 2 years; increasing slowly in size with marked dysphagia and hoarseness for 6 weeks; great pain and loss of weight. Operation, July 24, 1917; very radical operation; complete relief for 6 months; gradual recurrence and death 1 year after operation. For 6 months this patient had complete relief from pain and dysphagia. It seems as though this operation was justified.

CASE 12. Woman of 60; for 9 months there was steady growth of the left lobe. Operation elsewhere, April 16, 1918. Malignant mass encircled trachea and had been considered inoperable. Examination of specimen showed adenocarcinoma. Slow but steady growth, without symptoms, until 2 months before operation, which took place September 10, 1920, for a tumor the size of a lemon, adherent to the skin. At operation, under local anæsthesia, a radical subtotal thyroidectomy was done, although some of the cancer was left adherent to the left side of the trachea. Discharged in 10 days. Five X-ray treatments without effect. Ten months after operation the patient developed great dyspnœa, especially at night, with severe coughing and hoarseness. Bilateral abductor paralysis. Patient improved; advised to go home and to return if the symptoms became more severe. Death occurred 11 months after operation.

This case shows cancer of the thyroid, progressing slowly for 2 years, without symptoms. Had a more radical operation been done at first, followed by a thorough X-ray treatment, a cure might have resulted. The patient was relieved from a big tumor which probably would have ulcerated. This palliative operation was, I think, wise.

After this gloomy history of 12 cases, with the first as an exception, there remain 7 in which, although some of the operations were extremely radical, the results have shown that surgery and X-ray treatment were clearly justified, and 3 cases are now living and perfectly well.

CASE 13. Man of 66, who had a cyst removed from the left lobe in 1908, reported again in December, 1916, with a solid tumor under the scar, firmly fixed to the deep tissues, and with three small subcutaneous nodules. Operation, December 15, 1916, under novocaine; very radical operation with the excision of nodules performed; tumor extended deeply behind the clavicle. Diagnosis: adenocar-

Fig. 1.

Fig. 1. Case 15. Cancer of the thyroid. Photograph December, 1916. Recurrence 2 years and 5 months after first operation.

Fig. 2.

Fig. 2. Case 15. Recurrence after second operation. Photograph April 23, 1917.

Fig. 3.

Fig. 3. Case 15. After second operation, April 23, 1917.

cinoma. Discharged in 17 days. Twelve X-ray treatments from January 16 to October 10, 1917. Death from recurrence 23 months after operation.

CASE 14. Woman of 60; for 10 years had a tumor on the right side of the neck; has had three separate infections with increase of the growth and then retrogression. Examination showed a very large tumor, lobulated, and in part cystic, involving the right side and front of the neck, extending over and adherent to the sternum, as far as the third rib; very many tortuous and much dilated veins; external jugular over an inch in diameter. Diagnosis: adenocarcinoma of the right lobe with infection. Operation, March 5, 1910. With great difficulty, owing to bleeding and adhesions as a result of past infections, the upper and the lower flaps were reflected, leaving the adherent skin attached to the tumor. Sternomastoid muscle cut; with extreme difficulty a tumor, weighing over 5 pounds, with the internal jugular vein, was removed, as well as innumerable malignant glands. Operation lasted one and three-quarter hours, and I consider it one of the most formidable operations I ever did. Pathological report showed, in certain regions, proliferating papilloma, hæmorrhagic cysts and adenocarcinoma. The glands were adenocarcinoma. Uneventful convalescence. Nine months after the operation a recurrence appeared, the size of an apple, adherent to the skin. At the second operation, December 5, 1910, the tumor had infiltrated the lower part of the sternomastoid, extended behind the sternum, was adherent posteriorly to the common carotid and internally to the larynx and trachea and to the outer muscular wall of the œsophagus. By a most laborious dissection the whole mass was safely removed. Again there was an excellent recovery. January 25, 1912, the patient was in good condition. She died, however, of recurrence 3 years after the second operation.

Fig. 4.

Fig. 5.

Fig. 4 (at left). Case 15. Cancer of the thyroid. Photograph March 21, 1918, after fifteen X-ray treatments, begun January 11, 1917.

Fig. 5. Case 15. Cancer of the thyroid. Photograph March 21, 1918, after fifteen X-ray treatments, begun January 11, 1917.

CASE 15. Woman of 48 noticed a small lump on the right side of her neck 6 years ago. This tumor steadily increased in size, but with greater rapidity during the last year. There were no symptoms. Examination showed a tumor of the right lobe the

Fig. 6. Case 16. Cancer of the thyroid. Metastatic carcinoma in the chest. Roentgenogram taken August 1, 1917.

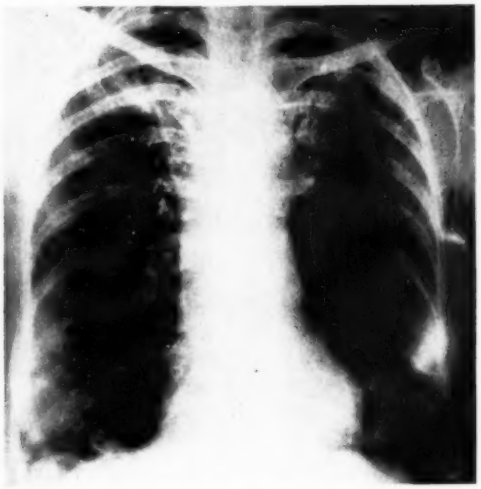

Fig. 7. Case 16. Cancer of the thyroid. Disappearance of lung metastases except in lower right base. Roentgenogram taken September, 1920.

size of an orange; the mass moved with deglutition and was elastic and tense. X-ray of the chest suggested an enlarged thymus or a substernal goiter. The right apex was definitely dull. Otherwise the report was negative. Operation, July 24, 1913; ether anæsthesia. The tumor was encapsulated and easily shelled out without rupture. It was, however, adherent to the laryngeal muscles. Diagnosis: adenocarcinoma. In December, 1916, she reported again. There had been a steadily growing recurrence for the past 2 years. The examination showed multiple cystic tumors involving both sides of the neck, more marked on the right, and pushing the trachea to the left. At this time there was no difficulty in phonation. Numerous tumor masses, slightly adherent to the internal jugular vein, were excised on December 26, 1916. Some of them were fairly well encapsulated. Pathological report: adenocarcinoma. Convalescence excellent. X-ray treatment begun January 11, 1917, by Dr. George Holmes. On March 24, 3 months after the operation, there were recurrences on both sides of the neck, with dullness behind the mediastinum. X-ray treatment pushed. On April 23, 4 months after the operation, the X-ray picture showed round areas, sharply defined, with dense centers scattered through both sides of the chest, quite characteristic of metastatic malignant disease. By February, 1918, all evidence of the disease had disappeared from the neck, except a few small glands in the left supraclavicular region. X-ray treatment continued. On December 23, 1918, 2 years after the operation, the shadows had disappeared from both lungs with the exception of one area in the right costophrenic sinus. On September 9, 1920, a slight induration under the right jaw, which had been present for several months, was growing smaller under X-ray treatment. Both lungs remained clear except for the before-mentioned metastasis at the right base, which had not changed. Her metabolism on October 2, 1920, after thirty-nine X-ray treatments, was minus 21 per cent, though there were no symptoms of myxœdema. The patient was thin, but stated that the cough which had bothered her for several months was considerably better. There was no bloody sputum. The patient died, probably from internal metastasis, at the end of December, 1920, $7\frac{1}{2}$ years after the first operation.

There is no doubt that operation was justified in this case and that the X-ray exerted a remarkable influence on the recurrences and metastases.

Case 16. Woman of 75; for 2 years there was a steady growth of a hard nodular tumor of the left lobe with enlarged glands. The whole mass with the glands was removed with the outer wall of the pharynx, on December 2, 1916. Wound slightly septic. Discharged 10 days after operation. Pathological report: adenocarcinoma. Reported on April 1, 1923, 7 years after operation, perfectly well with no evidence of recurrence.

Case 17. Woman of 46. For 8 years had a tumor in the left lobe of the thyroid which had recently grown larger and pressed the trachea to the right, as shown by the X-ray. The tumor was hard and round and partly intrathoracic; no symptoms. Operation, January 18, 1921; ether anæsthesia. Encapsulated tumor, size of a golf-ball, removed

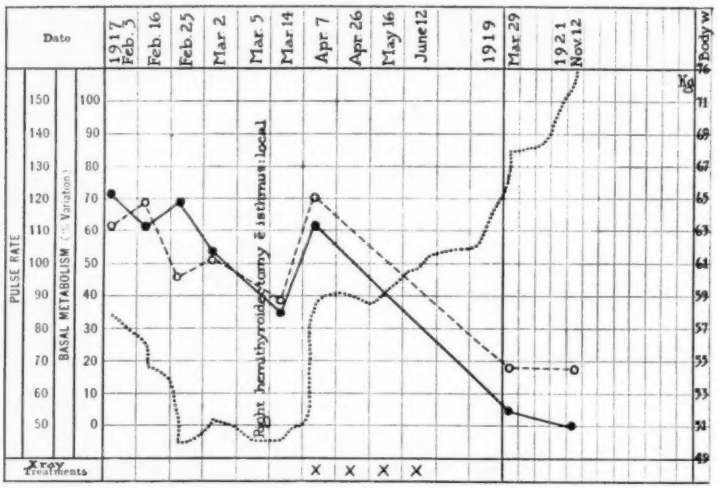

Chart 3. E. B., male, age 35. Duration 5 years. Graves' disease.

unruptured, with some adjacent thyroid tissue. Dr. Wright reported the growth as a carcinoma, but could not determine whether it was from the thyroid or parathyroid. Reported April 22, 1922, perfectly well; no evidence of recurrence; gained 25 pounds.

CASE 18. A woman of 74 first noticed a tumor on the right side 2 years ago, which had increased rapidly during the last month. Diagnosis: carcinoma. Operation, November 9, 1918: radical thyroidectomy with wide excision, including the internal jugular vein and right recurrent nerve. Pathological report: adenocarcinoma. Three erythema doses of the X-ray at 3 week intervals followed. Two years afterward she broke a hip in an automobile accident. The fracture united soundly. On April 6, 1923, she was in excellent health, with no evidence of recurrence.

CASE 19. A woman of 38; for 3 years steadily increasing growth of a sharply defined tumor in the median line, about the size of a hen's egg, extending down to the sternal notch; tensely fluctuant; no enlargement of the lateral lobes. Operation, February 20, 1913, ether anæsthesia. In the isthmus was an encapsulated tumor firmly adherent to the surrounding structures. As the growth would not shell out it was carefully removed by scissor dissection with adjacent thyroid tissue. Pathological report said: "A portion of the thyroid gland, consisting of the walls of a cyst, with a nodule the size of an English walnut, having a grayish-white section surface. Microscopic examination shows the tumor consisting of an irregular network of fibrous papillæ covered with a single layer of small deeply-staining cells and numerous irregularly-shaped follicles filled with colloid. There are wide bands of fibrous stroma which contain a number of small follicles. Several small lymph nodes adjoin one of these firm fibrous bands, and in them are solid columns of atypical cells. Diagnosis: adenocarcinoma with metastasis in the adjoining lymph nodes.

March: Wound soundly healed. She reported this year, April, 1923, perfectly well, with no evidence of any recurrence 10 years after operation.

In the above cases the age of onset was 1 at 25, 1 at 35, and in the others the growth appeared after 45 years of age. The duration of the tumor previous to operation was in 1, 9 months; in 2, 1 year; in 2, 2 years; in 1, 5 years, and in the remainder from 6 to 28 years. A study of this series and other cases of malignant disease of the thyroid shows two different types: In one the cancer occurs primarily in people beyond middle life, usually as a unilateral, less frequently as a bilateral goiter and grows steadily or rapidly. In the other type the cancer develops in a tumor of long duration, evidenced by a more or less sudden increase in the size or induration, with loss of weight, pressure symptoms, shown by nerve paralysis, or involvement of adjacent tissues or lymphatics. Particularly unfavorable are the cases in which the tumor is fixed to the trachea, with paralysis due to involvement rather than to pressure on the nerve. Favorable for cure are encapsulated adenomata which have undergone malignant degenera-

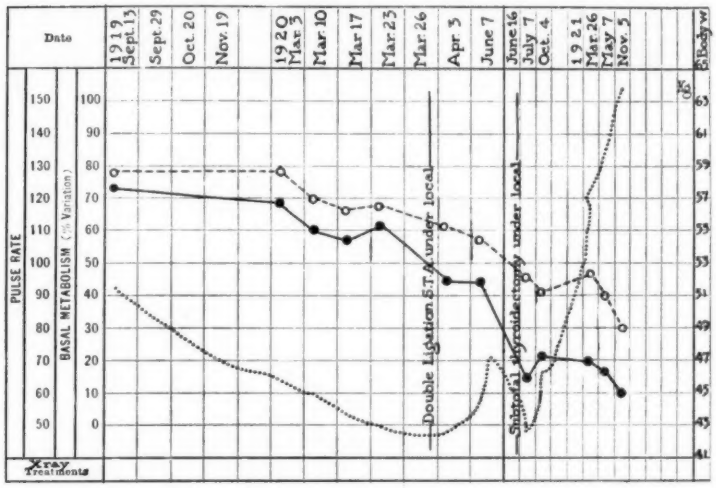

Chart 4. M. R., female, age 31. Duration 2 years. Graves' disease.

tion. The stony hardness of cancer may be simulated by calcification of the walls of cysts. A portion of a doubtful growth or a lymph gland under local anæsthesia may be removed for examination. Even if the report be negative and a reasonable suspicion of cancer in another part of the tumor exists I believe a radical operation should be done, for I have been unable to distinguish any difference in the character or extent of the growth which would aid me in determining that operation would be followed by a rapid recurrence, a long palliation or a permanent cure.

What is the best treatment when the diagnosis of malignancy is almost certain or confirmed by biopsy? Provided a careful X-ray examination of the lungs is negative, I believe a radical operation, although most formidable and exacting, should be attempted whenever it seems probable that all obvious disease can be removed. There is no doubt that general anæsthesia markedly increases the risk of operation in these cases, with the not infrequently attendant dyspnœa, nerve paralyses, and severe hæmorrhages. Under local anæsthesia, which I always prefer, the above objections are lessened, with the decided advantage that operation can be stopped at any time and continued at a subsequent date. If malignant disease must be left behind radium needles may be implanted and intensive X-ray treatment started, even on the afternoon of the same day. I believe a primary clean dissection will often postpone, if not entirely avoid, the need for tracheotomy. Nothing can be more distressing than the plight of late cases, which require an emergency tracheotomy through cancerous tissue, with the usual repeated hæmorrhage, dyspnœa, and pulmonary infections. Inoperable recurrences may be benefited by X-ray treatment, as shown in Case 16, where even the pulmonary metastases, with the exception of one place, apparently disappeared.

Unless my experience is peculiar, cancer of the thyroid is not a very rare disease. Exploration on suspicion seems the only rational procedure. Even if the diagnosis is clear in a majority of the cases, operation offers more in the way of palliation or cure than treatment by X-ray or radium alone.

TOXIC GOITERS

In the early part of this series no proper distinction was made between toxic adenomata and Graves' disease. It is easy to see, as one looks back, many errors of judgment in overoperating, although occasional grave risks were taken deliberately when the patient did not improve under rest and medical treat-

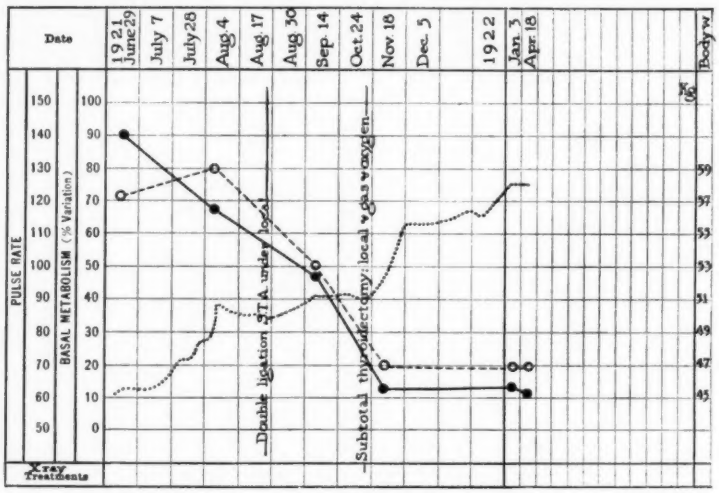

Chart 5. A. F., female, age 52. Duration 5 years. Graves' disease.

ment. The mortality has been steadily diminishing. In the 5 year period from 1904 to 1908 inclusive there was no mortality. From 1909 to 1914, 15 per cent; from 1914 to 1919, 14 per cent; from 1919 to 1920, 8 per cent, and from 1920 to date, January, 1921, 3 per cent. Twenty-six cases have been operated upon since January, 1921, with one death, and are considered, except for the mortality, too recent to analyze. In making up these figures, I have given the mortality by *patient and not by operation*. The total number of cases is 204, and though the series is small in comparison with the larger clinics, I have followed many of them personally for years. My secretary, Miss G., and Miss Burgess have enthusiastically co-operated in the endeavor to get end-results. It has often been difficult to arrange for patients, the majority of whom feel well, to come to the hospital breakfastless or to spend the night previous to a metabolism test.

It is often impossible to estimate the rôle of different factors as causes of death; for unsatisfactory anæsthesia, unexpected loss of blood, a heart already seriously damaged, hyperthyroidism and pulmonary infection may some or all be present in the same case. Occasionally, and particularly under gas and oxygen, patients have stopped breathing and have become cyanotic, but have recovered quickly enough to justify a continuance of the operation. It is now clear to me that when in doubt as to the wisdom of proceeding, the operation should be stopped at whatever stage, and the wound quickly sutured or packed with thin rubber dam or gauze. It is obvious that long, close co-operation between the surgeon and his team will do much to diminish the mortality in doubtful cases.

It has been our custom at the Massachusetts General Hospital, since the thyroid clinic was started with two medical men, a roentgenologist, and two surgeons, to give the roentgenologist, Dr. Holmes, an opportunity to demonstrate the use and limitation of X-ray therapy. Wherever there has been evidence of an enlarged thymus two or three X-ray treatments have been given. Whether radiation of this gland affects the syndrome, status lymphaticus, favorably we do not know, but there is an impression that after such radiation, the operative risk has been improved, although a part of this impression may be due to a lessening of the toxicity from the thyroid. I believe there is no doubt that X-rays improve and will cure certain cases of Graves' disease. Dr. Means and Dr. Holmes have recently reported 44 cases of exophthalmic goiter in which X-ray alone was used. Twenty-eight

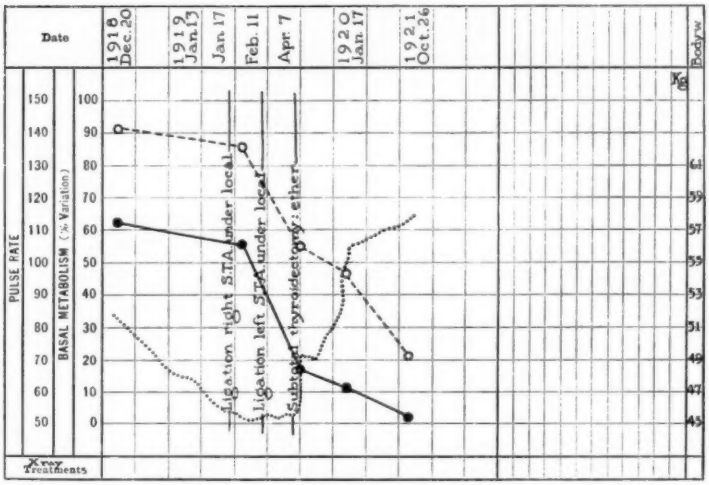

Chart 6. E. P., female, age 22. Duration 8 months. Graves' disease.

of these showed definite improvement, and 13 of this number, judged by a normal basal metabolism, were completely cured. In addition there were 12 toxic adenomata with 5 apparent cures. These cases have been treated during the past 3 years. There are also, in addition, 15 cases, all treated before 1915; 7 of these, examined in the spring of 1922, were apparently cured and are now perfectly well, according to normal metabolism rates. Time, of course, is a considerable factor in these cures, but this also applies to surgery.

After a period of rest, either with or without X-ray therapy, we perform a graded operation, depending upon our judgment, and consisting, as in other clinics, of preliminary ligation or ligations, hemithyroidectomy or subtotal thyroidectomy. It is easy to see my errors of commission in the past. In other words, there was then ignorance as to graded operation and a tendency to do too much.

Of the 204 cases analyzed, there occurred 24 deaths in the hospital and 9 deaths at various periods after discharge. I have divided the hospital deaths into four classes:

1. Hyperthyroidism as possibly preventable with increased knowledge.
2. Pulmonary complications which have been strikingly frequent in comparison with only one death in non-toxic goiter.
3. Cardiac complications.
4. So-called accidental deaths.

There were 13 deaths from hyperthyroidism, more frequent, as was to be expected, early in the series. Three deaths followed ligation under local anæsthesia.

1. In 1913, a man extremely toxic, suicidal, loss of 60 pounds in 6 months; in a dark room for 3 months. Double ligation. Death in 48 hours.

2. A man of 45; decompensated heart; cirrhosis of the liver; drug fiend. In 1911, double ligation. Death in 40 hours.

3. Operation, March 3, 1919, a single superior thyroid ligation upon a man who had lost 37 pounds in 2 months. Pulse-rate 126 and metabolism +85. The hyperthyroidism was slight, but marked acetonuria and glycosuria developed, with an irregular pulse of 80 on the sixth day. There were also nausea and vomiting. In spite of treatment, acetone and diarrhœa persisted, and on March 26, as a desperate resort, ligation on the other side was performed. This time there was marked hyperthyroidism with a pulse of 225. Death occurred on the fifth day.

In the first two cases I might have done a single ligation instead of a double one, but both operations were so easy that I doubt if the extra ligation made much difference. In the third case my only error, if there was any, was in operating at all.

4. A girl of 23 had had Graves' disease for 6 years, which had become severe in the last 6 months. She also had aortic insufficiency, mitral stenosis and

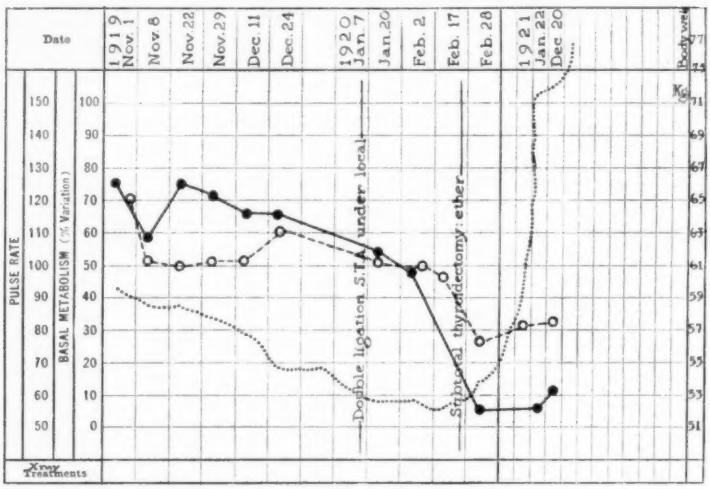

Chart 7. A. H., female, age 42. Duration 2 years. Graves' disease.

insufficiency. Pulse 130; metabolism +90. Rest in bed for almost 5 months and five X-ray treatments improved her condition, and on May 8, 1919, I did a double ligation. There was a moderate reaction. She had 5 months more of rest, and then, under ether, a subtotal thyroidectomy. Death occurred 7 hours after operation from marked hyperthyroidism. The case was complicated by her severe heart disease. The operation should have been limited to a hemithyroidectomy.

This last case was the only one which had preliminary ligation; the other 9 which follow had primary hemithyroidectomy or subtotal thyroidectomy.

5. A girl of 18; duration 7 months; marked toxicity. Right hemithyroidectomy, under ether anæsthesia, in 1910; vessels on the left ligated. Death 36 hours after operation.

6. Woman of 25; duration 8 years; acute symptoms for 4 months; myocarditis. She improved after rest in bed. Operation, under gas and oxygen, September, 1912. Hemithyroidectomy and ligation of vessels on the other side; severe hyperthyroidism; death on the third day.

7. Woman of 30; duration 2½ years; loss of 30 pounds; severe diarrhœa; metabolism, September 26, 1916, +48; pulse 150; metabolism on October 8, +58; pulse 133; loss of 4 pounds while in bed. Local anæsthesia was planned, but owing to the excitement of the patient, gas and oxygen were substituted and a subtotal thyroidectomy was performed, November 3. Typical hyperthyroidism; death 48 hours after operation.

8. Woman of 26; duration of acute symptoms, 9 months; rest in bed at Samaritan Hospital for 3 months, with improvement. Metabolism dropped from +84 to +65. Under ether, March, 1917, right hemithyroidectomy; cyanosis during the operation but condition apparently improved enough to justify the removal of a part of the left lobe. Typical hyperthyroidism; death in twenty-four hours.

9. A girl of 20; duration 5 years with exacerbation for 2 months; metabolism +80; under ether, in 1918, subtotal thyroidectomy; marked hyperthyroidism; death 24 hours after operation. Postmortem examination showed an extremely large thymus and hypertrophy and dilatation of the heart.

An analysis of these 5 cases shows them to be young women from 18 to 30 years of age; 2 were Jewesses with very little self-control; in 4 cases the symptoms were more or less acute for 2 to 9 months. In 1 the symptoms persisted for 2½ years with frequent diarrhœa and corresponding loss of weight. The average metabolism in 3 cases was +68. The first case was operated upon in 1904 and the last in 1918. With our present knowledge it seems clear that, because of the comparatively acute conditions, the relatively high metabolic rate, the nationality of two and the *youth of all*, two hemithyroidectomies with ligation of both vessels on the opposite side and three subtotal thyroidectomies was too radical treatment. At present the probable course would be preliminary ligation, with or without X-rays, and a hemithyroidectomy only instead of any operation on other side.

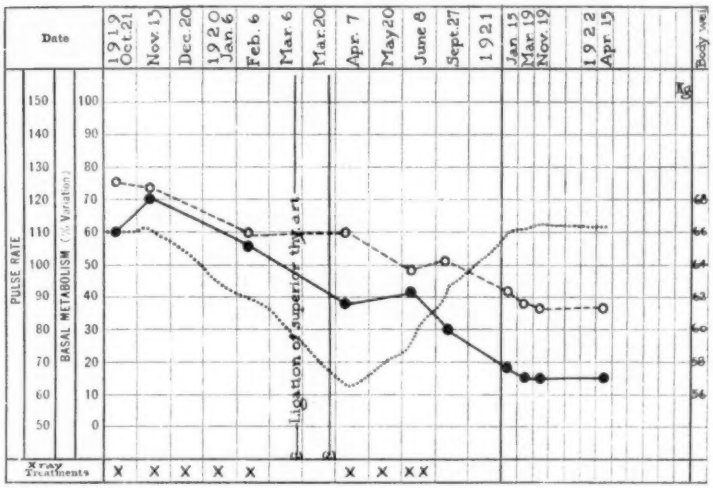

Chart 8. A. B., female, age 23. Duration 3 years. Graves' disease.

There were 3 deaths from hyperthyroidism in women of 40 or over:

10. A woman of 40; duration 1 year; morphinism; marked prostration. On May 6, 1912, under gas and oxygen, right lobectomy with ligation of both vessels on the left; hyperthyroidism well marked with delirium. Morphine in large dosage was probably continued by relatives; pupils markedly contracted. Death 11 days after the operation with terminal pneumonia.

11. A woman of 47; duration 5 years; œdema of legs; irregular heart; loss of eight pounds in 7 weeks; nausea and vomiting. Subtotal thyroidectomy in 1916, under gas and oxygen. Died in 48 hours from hyperthyroidism.

12. A woman of 57; acute symptoms for 8 months; loss of 36 pounds in the last 4 months; mitral insufficiency and auricular fibrillation; treated medically for 3 weeks, during which time she was given digitalis. Metabolism, March 26, 1917, +78; on April 10, +90. Subtotal thyroidectomy under gas and oxygen; unusual hæmorrhage; pulse 140, poor toward end of operation. Death in 7 hours.

Again it seems clear that, in the first case, a thoroughly tired, toxic woman should not have had so much surgery, apart from any question of morphinism. In the second case ligation should certainly have preceded thyroidectomy, which also applies to the third case. The rising metabolic rate should have been an indication for a less severe operation, particularly with the damaged heart.

13. There is one more case, a woman of 50, a Jewess, with high blood pressure and a toxic retrosternal adenoma causing obstruction. The metabolism was +48. Under anæsthol and ether, in June, 1918, a tumor the size of a large lemon, without much difficulty or bleeding, was removed from the right lobe and superior mediastinum. The patient died in 48 hours with high fever and bronchitis. There was some hyperthyroidism, but I do not see how the death could have been avoided, for, because of the nationality of the patient, operation under local anæsthesia would have been impossible.

PULMONARY COMPLICATIONS

There were 6 deaths from pulmonary infection, or at least there were 6 in which pneumonia or bronchitis played the chief rôle. There were 5 cases of death in young people, 2 of whom were 30 years old, 2 were 22, and 1 was 19. Two of these were Jewesses in which hyperthyroidism was also a factor.

1. A girl of 19; duration 1 year; very toxic. Under gas and oxygen a subtotal thyroidectomy was done in 1911. Bronchopneumonia and hyperthyroidism developed shortly after the operation. From the latter she recovered in a few days, but the pneumonia resolved very slowly. She lost her appetite, had considerable dyspnœa, with respirations between 30 and 40. A terrific hot wave intervened, the highest on record, from 104 to 98°, on July 10, 1911. On this day she died of heat prostration. The wound was entirely healed.

2. A girl of 22; duration 3 years; very toxic. A left ligation on October 1, 1913, was performed,

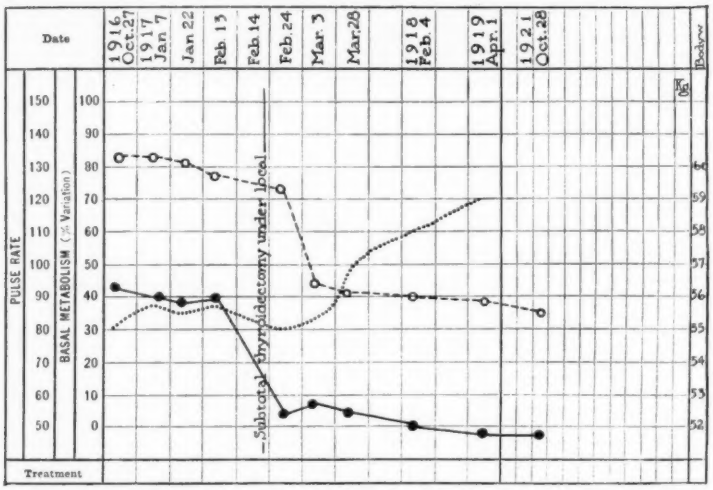

Chart 9. A. B., female, age 37. Duration 1 year. Graves' disease.

and on November 28, 1913, a right ligation. Advised to return for thyroidectomy, but did not report for 2½ years. Metabolism done in January, 1916, was +78, pulse 130. Rest in bed for 1 month, and on March 2, 1916, right hemithyroidectomy, with basting of the left lobe. She was sent back once from the operating room, the preceding week, because of her extreme toxicity. Death on the eleventh day from pneumonia and pericarditis. This patient lost the benefit of ligation because of her long delay in returning for thyroidectomy, contrary to advice.

3. A girl of 22; duration 4 months; rest in bed for 2 weeks. On March 28, 1913, under gas and oxygen, right hemithyroidectomy; death in 3 weeks from bronchopneumonia. Wound well healed.

4. A woman of 30; duration 7 years with thyrotoxicosis intermittently for the same length of time; loss of 35 pounds in 9 months; melancholia; metabolism +81. Right ligation in January, 1915, and 11 days afterward, under gas and oxygen, a left ligation. Patient stopped breathing for a time on the table and was sent back in poor condition. Death 48 hours later. Autopsy showed a clean wound, a very large thymus, purulent pericarditis, and pleuritis. My only critcism of this case is that the use of the X-ray might have reduced the thymus and hyperthyroidism and made her a safer risk. I cannot explain the pericarditis.

5. A woman of 30; duration 2 years; did not improve under medical treatment; mitral systolic murmur. Subtotal thyroidectomy on December 6, 1912; marked hyperthyroidism and pneumonia resulting in death 11 days after operation.

6. A woman of 36; duration 11 years; very toxic; under novocaine, on October 7, 1913, a right ligation was performed, and on the 22d, under gas and oxygen, a right hemithyroidectomy; slight sepsis of the wound; death 5 days later from bronchopneumonia.

FATAL CASE OF TETANY

A girl of 22, with Graves' symptoms for 8 months. On March 11, 1911, under ether, double superior thyroid ligation. In 1 year she had gained 25 pounds and was much better; further operation was advised and refused. She lost weight, 17 pounds in all, and finally returned for operation, October 23, 1914. Operation, October 23, 1914: subtotal thyroidectomy. Pathological examination: intraglandular hypertrophy. Until October 27 her convalescence was uneventful. On this day, at 5:30 p.m., about 78 hours after operation, the attention of the nurse was called to the patient. The thumbs were flexed bilaterally on the palms. She was seen 15 minutes later and then exhibited the usual signs of tetany; flexion of the thumbs on the palms, a sharp flexion of the fingers at the metacarpophalangeal joints, flexion at the wrists with slight flexion of the arms at the elbow and with the arms crossed in front of the body (Chvostek). Tachopnœa of from 40 to 50 per minute. Pulse only slightly elevated to 120. Complete numbness over the arms and neck. Feet in a slight degree of flexion. Could speak only above a whisper.

At 6 p.m., about one-half hour after the onset, calcium lactate, grains 30 by mouth. Condition subsided and at 7 p.m., only a slight flexion of the thumbs persisted. Calcium lactate, grains 15, at 7 p.m., and in the next hour she was apparently normal again. Had a good night.

October 27. Good day. Wound clean. Pulse 80. Chvostek sign in a mild degree. Had a good night.

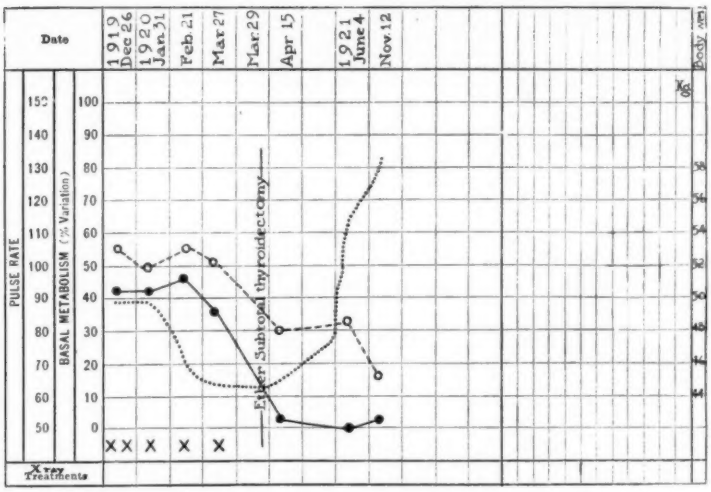

Chart 10. P. R., female, age 29. Duration 3 months. Graves' disease.

October 28. At 7.30 a.m., about 36 hours after the administration of the calcium, there was another attack of tetany, more severe. Tachopnœa from 60 to 70. Slight permanent retraction of the upper lip. Pulse 100. Feet in marked flexion and contractures of the hands more severe. Calcium, grains 15, 2 per cent intravenously. In two hours complete relaxation of the spasm. Put on calcium, grains 60 per day.

October 29. Excellent condition. Pulse 80. Exophthalmos less. Says she feels better than she ever has felt since she had Graves' disease.

November 1. Eating well. Excellent scar. Speaks only in a whisper. Chvostek persists. Slight spasm of the upper lip muscles.

November 6. Chvostek still persists.

November 10. Calcium reduced to grains 40 per day.

November 11. This morning, at 6.15 a.m., another slight attack with flexion of the thumbs, etc., but to a lesser degree. Respirations 30 to 35; pulse 80. Calcium, grains 30. Spasm disappeared save for a spasm of the thumbs. Calcium, grains 15, and by 8 o'clock all spasm was gone. Put on calcium, grains 60, again. White blood cells, 10,800.

November 11. Throat room: complete paralysis of both recurrent laryngeal nerves.

House officer's note. "This last attack shows how narrow is the margin of calcium equilibrium in her case when a drop of only 20 grains of calcium is sufficient to bring on tetany."

November 12. Nerve O. P. D. She has a reaction to induced currents (Paul). She was tired out and a condition of hyperexcitability was found. She reacted to one-fifth part of the stimuli necessary for normal. (Tried on several nurses at the same time.)

November 13. Shown to the Clinical Surgical Society. She was not unduly excited nor was there any rise in pulse.

November 16. Up and about.

November 20. Open ward. Slight Chvostek still. Pulse 70 in the daytime and at night as low as 56. Gaining in weight.

November 22. Headache; slight contraction of both thumbs in the morning. Calcium, grains 15, at 6.15 a.m. Calcium, grains 15, at 6.40 a.m., Spasm disappeared.

November 25. Same. Sore throat. Glands swollen; tonsils reddened. Temperature 102°. Slight attack. Calcium, grains 15, at 8.30, with relief. Is very nervous and cries a great deal.

November 26. Glands in neck larger. Throat red; tonsils swollen. Slight attack in morning. Calcium, grains 15, at 9.30 a.m. Irritable and nervous. Refused to speak to friends who visited her. Slight attacks in evening. Calcium in 2 per cent solution subcutaneously and subpectorally, grains 15 at 11.

House officer's note. "The interesting fact about this is that the acute infection is lowering her ability to assimilate the calcium ingested in some manner, as is shown by the fact that on the uusal 60 grains per day, tetany signs start, where before 60 grains was sufficient to prevent them."

November 27. Mentally irresponsible but physically better.

November 30. Irritable.

December 2. Parathyroid extract, grain $^1/_{20}$ in tablet form. Calcium, grains 40.

December 5. O. K.

December 7. Both cords in cadaveric position. Complete paralysis of both nerves.

December 8. Enormous appetite.

December 10. Calcium reduced to grains 30.

December 13. Sore throat; cervical adenitis; tonsils red. Slight attack. Calcium, grains 30, with relief.

December 16. Parathyroid increased to grain 1/10 three times a day.

December 17. White blood cells, 11,600.

December 20. Has gained 20 pounds since operation. Appearance of myxœdema. Hair dry and brittle; sluggish mentally. Calcium, grains 20.

December 23. Pulse poor and increased in rate. Dr. Lee says weakness of heart muscle; digipuratum.

December 27. Pulse better. No signs of tetany. Mentally irresponsible.

December 30. Better.

January 2, 1915. Went to bed at 6 p.m. Got up at 11 p.m., out of bed, seized the tumbler and pitcher and dashed them both on the floor. She wandered about the ward muttering, violently resisting the nurse. When seen she was in the linen closet, a typical case of acute mania—laughing, picking things from the air, etc. There was no contracture of the muscles and no Chvostek. In a few minutes more she suddenly became rigid, her hands contracted violently, the arms flexed sharply across her chest, accompanied by several generalized, tetanic convulsions. She then became absolutely rigid, ceased to breath, became cyanotic; the feet sharply flexed and the pulse could not be felt. She was laid out on the floor and calcium, grains 20, intravenously given, also 5 per cent solution subcutaneously. She then relaxed and again returned to the state of mania. Very restless all night.

January 3. Same. Knows her name and where she is only. Eating. Calcium, grains 60 per day

January 6. Insane; gets up unless watched. Restraint necessary.

January 8. Slight attack. Calcium, grains 30, intravenously. Sulphonal helps to quiet and morphine p. r. n. Paraldehyde not effective.

January 8. Violent. Restraining sheet applied. Temperature and pulse rising.

January 10. Talks incessantly. Some retention of urine.

January 13. Quieter and weaker. Death at 8.45 a.m., 2 months and 3 weeks after operation.

In the next 3 cases I have called the deaths accidental.

1. A woman of 29; Hebrew; severe Graves' disease; subtotal thyroidectomy on February 15, 1916. At the end of the third day a large infarct of the left lung occurred and caused death in 2 days.

2. A girl of 23; four X-ray treatments, reducing the metabolism from +77 to +47 in a little over 5 months and the pulse from 153 to 133. Subtotal thyroidectomy, under gas and oxygen, on May 2, 1917; pulmonary embolus with a large infarct of the lung caused death the following day.

3. A girl of 22; severe Graves' disease; steady loss of weight, 31 pounds in the last year, in spite of excellent appetite; duration 2 years; metabolism, February 13, 1920, +55. Two X-ray treatments. In March the metabolism was +38; losing more weight; pulse 120. Under rest in bed she gained 22 pounds; pulse 105 and metabolism +40. A subtotal thyroidectomy was performed May 18, 1920, under gas and oxygen. During the operation there was some cyanosis and irregular respirations, but she left the table in fair condition. Was put to bed, when she gave four short gasps and died. Autopsy showed status lymphaticus and a cyst of the pineal gland.

4. A Jewess of 40; menopause; melancholic and suicidal; refused operation on four successive days and finally consented if I would come immediately. Under ether, on October 1, 1909, right hemithyroidectomy Owing to the fair condition of the patient after this and to the probability that she would refuse another operation, I removed one-half of the left lobe against my better judgment. The pulse rose rapidly after operation and she died in 2 hours.

Of the 24 deaths in the hospital 13 died of hyperthyroidism, 6 from pneumonia or bronchitis, 2 from pulmonary emboli, 1 from tetany, 1 from status lymphaticus and 1 from shock after a too radical operation upon a suicidal climacteric Jewess.

Nine patients died after discharge from the hospital. One of these, a woman with double ligation in 1916, did not return for further operation, as she was advised, and died from her disease 1 year after discharge. Another woman, with double ligation, died 7 months after discharge, cause unknown. A third died from influenza and pneumonia, during the epidemic, 21 months after discharge. The fourth died 2 years afterward, cause unknown. A fifth was cured of his Graves' disease with a pulse of 72, but was accidentally shot 2 years afterward while deer hunting. A sixth, double ligation, had severe mitral disease. After operation she convalesced satisfactorily for 3 weeks, when she suddenly developed a right hemiplegia from an embolus. She lived 3 years afterward. The seventh was a woman of 40, who had had Graves' disease for 21 years and mitral disease for many years, with a dilated, uncompensated heart and auricular fibrillation. A right hemithyroidectomy was done under novocaine as a late palliative operation. She definitely improved but died 4 years later from cardiac decompensation. The eighth was a woman of 27; double sepa-

rate ligations in May and June, 1920; following the ligations, six X-ray treatments without improvement. In October, 1920, right hemithyroidectomy and removal of the isthmus. In December, 1920, metabolism was +6. In January, with pregnancy, her metabolism rose to +30, with a very slight return of symptoms. She had a normal confinement, but died January 29, 1922, from a pulmonary embolus, 40 days after confinement. The ninth, subtotal thyroidectomy in July, 1918; woman of 43 was cured of Graves' disease, but died in April, 1922, of internal malignant disease.

Of the 204 cases, 24 died in the hospital and 9 after discharge; 24 are unheard from. Of the remaining 147 cases, 26 of them, operated upon since January 1, 1921, are considered too recent for analysis. This leaves, then, 121 patients for analysis. From 45 of these I have received adequate reports from the local physician or competent answers from the patients themselves. I have personally examined 76 cases, in 73 of which final metabolic determinations were made. As many of the operations were done a long time ago, and in a few only ligations or hemithyroidectomy, the element of time and natural cure of the disease must be considered. In analyzing the end-results of 45 cases, which have not been personally examined by me and where no metabolic determination has been made, the word cure means that they have been freed from the symptoms of Graves' disease with the exception of exophthalmos.

UNIMPROVED

1. Woman of 51; double ligation, 1914; further operation refused; for years has been receiving organotherapy. Her condition is reported as not improved.

IMPROVED BUT NOT CURED

2. Woman of 33; in 1914, under local anæsthesia, right hemithyroidectomy; much improved but not cured.

3. Boy of 22; double ligation in May, 1919; X-ray treatment; metabolism, November, 1919, was +40; X-ray continued until April, 1920. Nine X-ray treatments after the operation. In July, 1920, improvement definite but not cured. Operation was indicated instead of a continuance of X-ray treatment.

4. Woman of 47; left hemithyroidectomy, April, 1911, with improvement. Patient lost sight of until 1919, when she reported with hypertrophy of the right lobe and a return of the symptoms. Operation was refused. X-ray treatment was advised. She reported again in 1922. Right lobe had again increased in size during the past 4 months; menopause a year ago. X-ray again advised owing to a very high blood-pressure, myocardial insufficiency and glycosuria. Under X-ray treatment the lobe has diminished one-half and the symptoms are less marked, but the patient is not cured.

CURED WITH MENTAL SYMPTOMS

5. A man of 23; right hemithroidectomy in 1919. In January, 1922, physically cured, but in Danvers State Sanatorium with delusions of persecution.

6. A woman of 43; duration 11 years with intermittent attacks; separate ligations in September, 1919; subtotal thyroidectomy in October; much improved but mental derangement increasing. In November, 1921, cured of Graves' disease, but committed to Danvers State Sanatorium with a diagnosis of climacteric insanity.

7. A woman of 55; hemithyroidectomy in March, 1913; March, 1916, much improved physically but subject to attacks of mental depression. In 1922 physically perfectly well, but attacks still occur.

8. A woman of 46; severe Graves' disease; subtotal thyroidectomy in 1918; is now cured of all her symptoms and can lead a normal social life, but at times has homicidal delusions, which, however, have led to no act of violence.

CURED WITH CARDIAC SYMPTOMS

9. A man of 40; typical symptoms of Graves' disease; partial thyroidectomy under local anæsthesia by another surgeon on August 18, 1917; hypertrophy of the left lobe; partial left lobectomy by the same surgeon, November 28, 1917; no improvement for 4 months; remainder of the right lobe hypertrophied. Operation by me, January 14, 1918; right upper one-half of lobe removed. In October, 1921, cured of Graves' disease, but his heart is seriously impaired.

10. A woman of 45; typical symptoms; in addition, myocardial disease, systolic murmur, albuminuria and approaching menopause. Subtotal thyroidectomy under local anæsthesia in 1917; in fall of 1921 her doctor says that the Graves' symptoms have disappeared, but the patient is a cardionephritic with a very high blood-pressure and subject to uræmic attacks. Pulse 80.

11. A Jewess of 18 with multiple congenital valvular disease; ligations under local anæsthesia 1913 and 1914 with improvement. Right hemithyroideomy in 1920. Cured of Graves' disease. In January, 1921, survived a severe attack of pneumonia and streptococcus septicæmia. This girl, though at first a very bad risk, was operated upon because I did not believe her congenital heart could bear the toxæmia of Graves' disease. I am convinced that had she not been operated upon she would certainly have died from pneumonia in 1921.

12. A woman of 50, with myocardial disease and mitral insufficiency; œdema of both legs. Right hemithyroidectomy with isthmus and ligation of vessels on the left in 1911. Show and gradual improvement in spite of heart. In 1921 she is a cure, but has occasional attacks of cardial decompensation.

CURES

These cases which follow are cures after various operations.

13. Double ligation in 1916, woman of 33; in 1922 she is cured.

14. Double ligation in 1911 for severe Graves' disease, girl of 20; hemithyroidectomy by another surgeon in 1913; now perfectly well.

15. Double single ligations in 1914, woman of 30; right lobe and isthmus removed one month afterward. In 1922 she is cured.

16. Double ligation under local anæsthesia; man of 23, in November, 1912. Hemithyroidectomy in December, 1914; in 1921 a striking example of a complete cure.

17. Right hemithyroidectomy and multiple suture of the left lobe to cause anæmic necrosis, performed on a woman of 28, in December, 1911. She became temporarily insane but recovered in a few weeks. Now married and perfectly well, October, 1921.

18. A woman of 28; several X-ray treatments without improvement; hemithroidectomy in 1908; married in 1910; two children; puerperal mania after second childbirth, but recovered and is now perfectly well.

19. A woman of 29; very severe Graves' disease; right hemithyroidectomy in 1908; has since married; in 1922 has three children and is well.

20. Hemithyroidectomy with removal of isthmus, woman of 35, in 1915; complete cure.

21. Right lobectomy in 1911, woman of 27; in 1922 she writes she is working in a restaurant and is perfectly well.

22. Hemithyroidectomy in 1911 for severe Graves' disease, woman of 50; in 1922 a cure.

23. Hemithyroidectomy in 1917, woman of 25; in 1922 she reported that she had gained 40 pounds and was cured.

24. Removal of right lobe and isthmus in 1911, woman of 26. In June, 1915, was very much better but not cured. In October, 1921, she was in perfect health.

25. Removal of left lobe and isthmus in 1917, woman of 28, in 1921 she writes she never felt better.

26. Right hemithyroidectomy in 1917 in a man of 39; metabolism before operation, +60. In May, 1922, metabolism +3. In 1922 patient is perfectly well.

27. Left hemithyroidectomy and removal of isthmus in 1918, woman of 24; in 1922 a complete cure.

28. Right hemithyroidectomy under local anæsthesia in June, 1920, woman of 38; in August, 1921, she is cured.

29. Left hemithyroidectomy, woman of 26, in January, 1919. In 1922 a cure.

30. Left hemithyroidectomy, woman of 36, in May, 1912. In 1921 a cure.

31. Left hemithyroidectomy in 1920, negress of 40 with a toxic adenoma. Operation under local anæsthesia. In October, 1921, is cured.

32. Separate double ligations in December, 1913, woman of 26. In November, 1915, subtotal thyroidectomy. In March, 1922, completely cured.

33. Subtotal thyroidectomy under local anæsthesia in 1916, woman of 36; in the fall of 1921 perfectly well.

34. Subtotal thyroidectomy, woman of 44 on March 18, 1918. Persistent bilateral abductor paralysis required a trachectomy 6 months afterward. In 1922 cured of all symptoms of Graves' disease but still wears a tube.

35. Subtotal thyroidectomy, under gas and oxygen, in 1917, woman of 45. Patient married shortly after leaving the hospital; in 1922 she has three children and feels perfectly well.

36. Woman of 36; right hemithyroidectomy early in 1917, and in June of the same year two-thirds of the left lobe was removed. In April, 1919, she was working daily and feeling fit with a metabolism of +10. In 1922 she was married and is well.

37. Subtotal thyroidectomy, woman of 21, July, 1919. In 1921 she was perfectly well. She is now pregnant with no symptoms of Graves' disease and is well. Successful pregnancy in March, 1922.

38. Subtotal thyroidectomy in 1920, woman of 29; in September, 1921, she is perfectly well.

39. Subtotal thyroidectomy, woman of 40, in November, 1915. No note of her progress until November, 1921, when she was in perfect health.

40. Woman of 48; right hemithyroidectomy with removal of isthmus, under local anæsthesia, in 1916. In January, 1917, partial resection of the left lobe. Has gained by 1922, 39 pounds and is a complete cure.

41. Subtotal thyroidectomy in 1917, woman of 31; in August, 1921, is cured except for exophthalmos, which is still marked.

42. Subtotal thyroidectomy, under local anæsthesia, in 1911, woman of 29; in October, 1921, completely cured.

43. Subtotal thyroidectomy in February, 1918, woman of 47, followed by a bilateral abductor paralysis, probably hysterical. In 1922, the larynx was examined and found to be normal. She is in perfect health.

44. Subtotal thyroidectomy in 1919, woman of 30; cured. Successful confinement in October, 1921. In February, 1922, is perfectly well.

45. Subtotal thyroidectomy, woman of 34, in February, 1920; in November, 1921, completely cured.

In reporting the 45 cases not personally examined by me, I used the word *cure* as meaning that they were freed from their

previous Graves' symptoms and able to do their ordinary work. I must confess, however, that such a cure is often a relative term, for with all the complications which attend this complex disease, physical, neurological and mental, acute or chronic, in the young or in the old, it must be that many patients come for treatment with organs already so damaged that a *restitutio ad integrum* could never take place. For this reason I have taken little interest in the percentage of figures of so-called cures. When is a patient with Graves' disease really cured? I believe we must consider first the disease and then the patient. I suggest that the best index of cure of this disease is a *permanent reduction of the basal metabolism to normal*. This is all that the X-ray or surgery can accomplish, and more quickly than rest, medicine, and the natural burning out of the disease with its permanent degenerations. If this conception of a cure be true we see the limitations of surgical treatment. Operations will then be divided into curative and palliative as in other diseases. A real *cure* of the *patient* may be expected only when at the time of treatment no damage to the tissues has resulted which may not be repaired by time. No matter how radical the operation, even if the metabolism rate becomes normal, it must be a palliative operation, so far as the patients cure is concerned, if permanent changes have taken place, from which recovery is impossible. This fact, I think, is too frequently forgotten in our endeavor to claim for surgery complete cures in Graves' disease, for it follows that a cure of the patient depends quite as much on the stage of the disease and attendant complications as upon a wise choice of graded operations. For example, exophthalmos may exist long after the patient is well; valvular disease, cardionephritic conditions and chronic bronchitis will outlast treatment; but instead of considering these as contra-indications to operation I consider them as indications for palliative operation, to relieve the patient as soon as possible from the added toxæmia of Graves' disease. I have been surprised at the improvement in several instances of chronic valvular disease where this additional burden has been lifted.

Of 76 cases personally examined, there are 4 cases on whom no final metabolism tests were obtained. One was a case of double ligation in October, 1918, followed by six X-ray treatments. She was confined in April, 1922, and is now living and well. Another is a woman who had a double ligation and hemithyroidectomy in February, 1915. She is now well with a pulse of 80 and working regularly every day. Another is a woman operated upon in February, 1914, double separate ligations and in November, 1915, subtotal thyroidectomy. She reported in 1921 cured of Graves' disease and in every way clinically a cure. Another, a woman operated upon in May, 1915, subtotal thyroidectomy, reported in 1922 perfectly well.

While the following analysis of results with regard to a normal basal metabolism shows a surprising number of cures after ligation and hemithyroidectomy, with or without X-rays, the most rapid and permanent results, as would be expected, have followed ultimate subtotal thyroidectomy.

DOUBLE LIGATION

Of 13 ligations, in a few of which the X-ray was also used, we have 11 recent metabolisms. Nine of them were within normal limits; by that I mean that their metabolism rate was plus or minus 5. One of these patients, who was treated by separate double ligations in May and October, 1920, with six exposures to the X-ray, has exactly doubled his preoperative weight to 164 pounds, and is perfectly well. Another case, a young girl, in October, 1919, with a metabolism of +70, had a separate double ligation in March, 1920, and subsequently nine X-ray treatments. She showed a remarkable disappearance of a very large goiter, and although now 6 months pregnant, her metabolism is only +13. In contrast to this is a woman, operated upon also in 1920, a double ligation, who has had eight X-ray treatments and is uncured. She was 5 months pregnant in November, 1921, with a metabolism of +51 and pulse 108 to 128. She refused further operation. In December, 1921, patient gave birth to a dead baby. She has since gained 6 pounds and the pulse is 84.

HEMITHYROIDECTOMY

Of 50 hemithyroidectomies we have final metabolic determinations in 35. Hemithyroidectomies in this series have shown some surprising end-results with approximately normal metabolic rates. In this, I believe, time is a factor. On the other hand, there are striking examples in which with hypertrophy of the remaining lobe, there have been severe recurrences of symptoms. One man in particular I have in mind:

In 1908 his normal weight was 198. After his symptoms developed he lost 84 pounds. After a hemithyroidectomy, on August 24, 1919, he gained to 182 pounds with a pulse of 72 on May 10, 1913. Owing to overwork there was a recurrence of symptoms with some hypertrophy of the other lobe, and in December, 1916, his weight fell to 120. Following a year's rest he recovered and his weight rose to normal again. For several months he had been running down hill with noticeable enlargement again of the left lobe. Influenza in January, 1920, increased these symptoms and he lost 44 pounds, with tachycardia and a metabolism of +56. On March 18, 1920, under local anæsthesia, four-fifths of the left lobe was removed. On April 6, 1920, his metabolism was +6 and his pulse 68. In six months he was perfectly well, again weighing 200 pounds. In August, 1922, he was maintaining this weight and is still well.

Another, a man of 55, had a double ligation on May 6, 1914, and in June of the same year a right hemithyroidectomy. He was apparently well until he had influenza in 1918, which was followed by hypertrophy of the other lobe and a return of the old symptoms, with auricular fibrillation. In spite of X-ray treatment for over a year his metabolism in January, 1922, was +37 and he was not cured.

Cases such as these and many others show a definite connection between infections and exacerbations of the Graves' symptoms, in the same way that the toxic thyroids after operation are found to have a predisposition to pulmonary complications when compared with the non-toxic goiters.

A man of 33 had a right hemithyroidectomy with basting of the left lobe, in April, 1915. He felt at his best 1 year after the operation. Since then he has had a gradual, though slight, return of the old symptoms. He feels that operation helped but did no cure him, although he can do a regular day's work. He has gained 13 pounds and his pulse has dropped from 100 to 90. The metabolism on November 8, 1921, is just what it was before the operation on April 19, 1915, +30 per cent. In other words, in spite of operation six years ago, he is still uncured.

A woman operated upon in March, 1917, has had hypertrophy of the left lobe. Her metabolism is +22 per cent, but she is working regularly. She has regained her normal weight and her pulse has dropped from 105 to 92.

With these exceptions the operations of hemithyroidectomy has resulted in an unexpected number of cures, judged by the standard of metabolism.

1 case in 1909 is +3 per cent;
1 case in 1911 is +11 per cent;
4 cases operated upon in 1912 average +3 per cent;
5 cases in 1913 average +5 per cent;
5 cases in 1916 average +5 per cent;
5 cases in 1917 average +½ per cent;
6 cases in 1919 average +5 per cent;
5 cases in 1920 average +5 per cent.

SUBTOTAL THYROIDECTOMY

Of the subtotal thyroidectomies we obtained 28 metabolic determinations in 50 cases.

1 case in 1909 is 0 per cent.
5 cases in 1911 operated upon average +3 per cent;
3 cases in 1914 average +1 per cent;
3 cases in 1915 average 0 per cent;
2 cases in 1916 average +5 per cent;
6 cases in 1919 average +1 per cent;
1 case was pregnant with a metabolism of +10 per cent;
7 cases in 1920 average +6 per cent.

There have been 3 cases in which the metabolism was subnormal. In all of them since the operation there has been a marked increase in weight. In none of them was there definite evidence of myxœdema:

CASE 1. A man of 40; before operation, weight 92 pounds; double ligation in July and August, 1913; no X-ray treatments. In 1917 and 1920 he had two relapses. In March, 1922, his metabolism was −13 per cent and his weight 171 pounds.

CASE 2. A woman of 41; normal weight 158 pounds. In June, 1913, she weighed 136 pounds; on August 20, 1913, right hemithyroidectomy and ligation of the left superior thyroid artery. On November 8, 1914, two-thirds of the left lobe was removed. On October 15, 1921, she weighed 211 pounds, pulse 54 and metabolism −16 per cent. Under thyroid her weight dropped to 201 pounds, the pulse rose to 70 and the metabolism to −5 per cent.

CASE 3. A woman of 45, whose normal weight was 169 pounds, weighed 125 pounds before a subtotal thyroidectomy on April 29, 1920. Her metabolism previous to operation was reported as +30 per cent, but all her symptoms were more definite than the metabolism would suggest. On October 15, 1921, she had regained her normal weight and 5 pounds more. The pulse was 80 and the metabolism −17 per cent. In January, 1922, she weighed 187 pounds. Under thyroid tablets she lost 3 pounds, but says she feels no differently.

There is then a possible danger of subnormal metabolism and myxœdema after a surgical procedure as well as after treatment with the X-rays, although a definite diagnosis of myxœdema, as before stated, could not be made in these cases.

I wish now to speak of an unfortunately large number of injuries to the recurrent nerves in this series, excluding malignant cases, amounting to 10 per cent. Most of these, though not all of them, occurred in the earlier operations, when I frequently performed total lobectomy and often delivered the lobe with fingers or made traction upon it with double hooks. A very small number recovered from the paralysis, though, as I have said at the beginning of the paper, the voice often becomes almost or quite normal in a few months. In particular I wish to mention 5 most distressing cases of bilateral abductor paralysis. Two followed operations by other surgeons and 3 are my own cases. One entirely recovered at the end of 6 months and was largely hysterical. A second followed operation in a girl of 16 for non-toxic goiter, and was apparently a factor in a rapidly fatal influenza-pneumonia 4 years after operation. In a third, tracheotomy was necessary, and although this operation was done 4 years ago, she still wears a tube. As the voice in these cases, although high-pitched, is not otherwise abnormal and the patients suffer only from dyspnœa at night or after physical exertion, the condition is probably more common than is recognized.

A careful laryngological examination is imperative. Until recently the laryngologist has hesitated to operate upon them locally. It is to be hoped that Chevalier Jackson's recently advocated ventriculocordectomy will cure this dangerous condition.

CONCLUSIONS

1. I believe that the X-rays, through the action on the thyroid and possibly on the thymus, will diminish the risk of operation and will permanently cure certain cases of Graves' disease. On the other hand I have seen cases in which X-ray treatment, though persisted in for as long as 2 years, has had practically no effect. Surgery promptly cured.

2. If 6 months' treatment with X-rays is not efficient, operation is indicated.

3. The best index of a cure of Graves' disease is a *permanent reduction of the basal metabolism to normal*.

4. Whether the patient will be cured or not depends on the stage of the disease at which treatment is instituted and the degree of irreparable damage which has already resulted.

5. Though ligation and hemithyroidectomy may cure many patients, ultimate subtotal thyroidectomy most quickly and permanently reduces the metabolism to normal.

6. The psychoses of this most interesting disease, which seems frequently to occur in neuræsthenic individuals, requires long after-treatment.

DISCUSSION

ARTHUR D. BEVAN, M.D., CHICAGO: I wish to emphasize the great value of local anæsthesia in toxic goiter cases. In my own work in a large series of very toxic cases I have practically discarded any form of general anæsthesia, whether ether, nitrous oxide or oxygen, and I am quite sure that this has made a very great change in my results.

Then, too, I am much impressed with the importance of operating on the bad cases by installments, not doing too radical an operation at first. Preliminary ligations are of value before considering the advisability of the actual removal of the gland; my own experience has been that the ligation of one thyroid is not of very great service; ligation of two is of very definite service and ligation of three has usually a very marked effect upon the reduction of the toxic symptoms. I would like to emphasize this very strongly, because I have seen many cases die under a general anæsthetic under ether and gas and oxygen, and I am much impressed with the great importance of operation under local anæsthesia in the bad cases.

One word in regard to basal metabolism: I find my own attitude toward this subject about this. We have had basal metabolisms taken by one of our colleagues, who is very well trained in this department, for some time, but I find that I am constantly

determining the question for or against operation by my own impressions of the clinical picture and that I am not guided by the metabolic rate. It is a good deal the same as a leucocyte count in an appendix operation or some other abdominal lesions where the clinical picture definitely determines the question of an operation whether the leucocyte count is in favor or against

MARTIN B. TINKER, M.D., ITHACA, NEW YORK: I was much interested in hearing Dr. Porter's report, and also to learn that they have really cured malignancy of the thyroid. In my paper I called attention to the fact that certain Fellows of this Association take a very pessimistic view with regard to thyroid malignancy, particularly where the disease is so far advanced that a probable diagnosis can be made before operation. There are at least 4 cases reported by members of this Association in which cure has lasted over 4 years after removal of such malignancy.

Dr. Porter spoke of some of the more desperate cases in which he had been obliged to remove a portion of the jugular in connection with the removal of the thyroid. We have had at least two such cases, and in certain cases where the infiltration of the tissues of the neck has gone on so far that it would be impossible entirely to remove all of the disease without killing a patient, we have used radium and have two patients living over 5 years. Both patients were treated by Dr. Howard A. Kelly, of Baltimore.

As regards the use of the roentgen-ray in these cases, it seems to me that we are still in the experimental stage and it is doubtful what the actual effect is in such cases. I would like to put on record at least 3 instances in which patients with moderate toxæmia or no toxæmia have been thrown into a state of extreme toxæmia, apparently the result of the use of the roentgen-ray, by men who are supposed to be very good in their line. They were not all by roentgen-ray men of my own locality. My own observation is that those patients treated by by roentgen-ray are among the patients who develop myxœdema afterward. Some of you will recall that Dr. Osler, in his *Practice of Medicine*, states that myxœdema following thyroid operation is extremely rare in this country, only 2 cases having come under his observation, and later 1 case was apparently cured. This is a very low percentage of myxœdema, but with the use of the roentgen-ray I feel that there is a very great increase. I have observed a number of cases in which myxœdema has resulted in these cases.

As to the reliability of the metabolic rate as a criterion of hyperthyroidism, is it not true that patients with a persistently high metabolic rate but in whom other clinical symptoms did not check up proved to be suitable for operation?

I believe that the many-stage operation in toxic goiter cases has, in the experience of a large number of men, made the difference between life and death.

WALLACE I. TERRY, M.D., SAN FRANCISCO: I wish to sound a warning against the use of roentgen-rays in adenomata of the thyroid, particularly where the adenomata constitute the greater part of the goiter. I have seen a number of cases of myxœdema follow the use of roentgen-ray for adenomata—the active part of the thyroid itself is destroyed.

A. MACLAREN, M.D., ST. PAUL, MINNESOTA: It seems to me that the question of local anæsthesia is a very important one in operations for goiter. I believe there is less danger of bronchopneumonia, and we do away almost entirely with the danger of tying the recurrent laryngeal nerve. I pinched a recurrent laryngeal nerve a year ago. I immediately recognized the fact from the harsh, rasping voice of the patient. I immediately took off the clamp and I had an opportunity to examine her larynx immediately afterward and again a week ago. She had no paralysis of the vocal cord.

C. A. PORTER, M.D., BOSTON (CLOSING): I merely wish to emphasize three points. I have operated upon many patients under local anæsthesia, which I always use, when there is any question of pressure on the trachea.

In 2 cases there was a marked increase in weight and the question of myxœdema arose. In only 1 case were there clinical symptoms. This patient normally weighed 150 pounds, which dropped to 136 pounds in 1 month. In August, 1913, I did a right hemithyroidectomy and ligated the superior thyroid artery. She improved following the operation, but still had some symptoms. In the latter part of 1914 I removed the anterior two-thirds of the left lobe. She was lost sight of until October, 1921, but she said she had steadily improved in the meantime, but complained of sleepiness and a growing discomfort, due to overweight, which was 211 pounds. Her metabolism, done at Dr. Means's laboratory, at the Massachusetts General Hospital, was —16 per cent. She was at once put on thyroid tablets, grains ½ which was continued for 4 months. In March, 1922, her metabolism was —5 per cent and her weight had dropped to 200 pounds. She was generally much improved and the thyroid was discontinued. She is now 46 years old.

There were 2 cases of myxœdema following roentgen-ray treatment, both of which yielded to thyroid tablets. This was discontinued after 6 months without a return of the symptoms.

In regard to metabolism, I consider it only a very important factor in diagnosis, but I wish to emphasize its very great importance as an indication of cure, as far as roentgen-rays and operation can cure overactivity of the gland. In other words, if the metabolism has been reduced to normal we can call the patient cured of Graves' disease in so far as a cure is possible. Exophthalmos may persist and there may be permanent visceral lesions or myocarditis, but these are the aftermath of Graves' disease, not the disease itself.

A METHOD FOR THE LOCALIZATION OF BRAIN TUMORS IN COMATOSE PATIENTS

The Determination of Communication Between the Cerebral Ventricles and the Estimation of their Position and Size without the Injection of Air (Ventricular Estimation)

By WALTER E. DANDY, M.D., Baltimore
From the Department of Surgery of the Johns Hopkins Hospital and University

IF the character and location of all brain tumors were known or easy of determination, the treatment would be greatly simplified. If it could be demonstrated that the character or position of the tumor was such as to prevent its removal, palliative treatment would at once be instituted as the utmost resource at our command. But if both the character and position of the tumor were known to be such as to make its removal probable or even a possibility, every effort would be directed toward its extirpation, this being the only hope of a cure.

Unfortunately, however, not all of this information is as yet attainable even after all examinations have been made. In only exceptional cases, as for instance tumors of the brain-stem and of the left temporal lobe, can we know that its extirpation either is not possible or is not justifiable. Although there are often indications that tumors either do or do not lend themselves to extirpation, the evidence on this point is most unreliable and may be just as misleading one way as the other. With few exceptions, the character of the tumor is not ascertainable until the growth is actually seen and examined at operation. Because of the progressive, necessarily destructive, and fatal course of these lesions unless completely removed by operation, the patient's only hope lies in the assumption that *all* tumors are curable until proven otherwise.

Fortunately, we are now able to determine the *location* of practically all brain tumors, so that by their inspection at operation the character of the growth can at once be known and either the palliative or curative treatment instituted at that time. With very few exceptions, the kind of tumor can be as accurately told by its gross appearance at operation as by a microscopical examination. Roughly estimated, not many more than 50 per cent of all brain tumors are localizable by neurological and roentgenological examinations, and it is for the localization of the other half that cerebral pneumography is of the greatest value.

We believe very firmly that no surgical treatment should be attempted until the location of the tumor is as precisely known as possible; that *primary* palliative treatment should never be done until a tumor is known not to be removable. We feel that the only treatment for brain tumors is to treat the *cause* directly; and that the tumor should be *completely* extirpated, and promptly, when possible.

There are times when this procedure may seem impractical or very difficult. Particularly is this true in those patients who are seen for the first time in the last stages of intracranial pressure, i.e., when in coma or when coma is impending. But under such circumstances, an accurate localization is far more important than when the patient's general condition is good. The correct treatment will often save the patient's life, while a misdirected operation will merely hasten the end. Cerebral pneumography[1] has been invaluable in these cases, for the patient may be so deeply unconscious that the results of the neurological examination may be negligible and the history obtained from others either inaccurate or misleading. However, in these cases the use of cerebral pneumography may, in itself, be very serious on account of the aggravations of pressure symptoms due to the effects of the air (a factor now largely under control), but still more so because of the time lost in making the examinations, and may reduce, more than it helps, the chances of a cure.

[1] I regret that press of time has so far precluded the publication in detail of the large series of brain tumors in which the use of cerebral pneumography has been the means of localizing the growth. It is hoped that this may appear in the ensuing year

If, under these circumstances, it were possible to make a localization of the tumor without injecting air into the ventricles, the patient's chances would be considerably increased. It is the purpose of this paper to propose a quick method by which a localization can usually be made *in such emergencies*. It is not without its possibilities of error but, taking everything into consideration, it seems to offer the most to the patients in their very desperate condition. It is recommended with hesitation and only as an emergency procedure. It is possible that the procedure may be useful in a few cases where the information obtained is sufficient to eliminate a definite region of the brain, when it seems certain that the tumor can be in one of only two possible situations. At all other times when there is doubt as to the tumor's location, presuming, of course, that the patient's condition is favorable, the other precise method of cerebral pneumography should be used.

The method proposed is to *estimate the size, position, and intercommunication of the ventricles by aspiration of the fluid in the lateral ventricles (and at times from the cisterna magna)*. We have learned from necropsy material but particularly from ventriculography that practically all brain tumors which cause intracranial pressure alter the size, shape, or position of part or all of the cerebral ventricular system; and the situation of brain tumors is, therefore, determined by the deviations in the size, shape, and position of the ventricles.

The position of the lateral ventricles can be determined by ventricular punctures; their size by measuring the fluid in the ventricles; and their communication with each other by injecting a dye into one ventricle and testing for the color elsewhere in the ventricular system. This information, while it leaves much still to be desired, is usually at least sufficient to tell whether either cerebral hemisphere or the cerebellum is the likely seat of the tumor.

Since the introduction of cerebral pneumography, it has been our custom to make a small perforator opening in the occipital region of *both* sides of the skull. Frequently one ventricle is collapsed or displaced by a tumor and cannot be reached by ventricular puncture, but it will be exceptional for both ventricles to be inaccessible. Usually the puncture of only one ventricle is necessary for cerebral pneumography, but since we cannot foretell which ventricle can or cannot be reached, and since at times both ventricles must be tapped, it is better to have both ventricles under control. The two openings can be made as easily and safely as one. The occipital region is chosen because the largest part of the lateral ventricle, the vestibule, is most accessible from this point. Moreover, the vestibule of the ventricle is, on the whole, less easily collapsed and dislocated than other parts of the ventricle. At times we have used bilateral punctures of the anterior horns of the ventricles but here the ventricles are smaller and consequently harder to enter. Moreover, dislocation and collapse of both anterior horns is more likely because they are closer together and, therefore, more equally affected by any pressure directed from the side. The vestibules and posterior horns are farther apart and are less equally occluded by the same pressure. Another anatomical factor which carries weight is that the anterior puncture must be nearer the midline and consequently through a field of larger veins which are nearing the longitudinal sinus. These may easily be punctured, whereas the posterior puncture is through a less vascular area. The lateral puncture into the descending horn has been used very sparingly and practically never bilaterally. At times a patient has previously had a decompression performed and an attempt may be made to enter the ventricle under these circumstances. A lateral puncture of the left side would hardly be considered because of the important speech areas which the needle must traverse. For ventricular estimations we have used the same posterior approach to the ventricles. *Punctures of both ventricles are then always necessary* (Fig. 1).

THE POSITION OF A LATERAL VENTRICLE

By experience it will be known that a normal lateral ventricle should always be entered from a given point when the ventricular needle is nserted in the proper direction

and to a given depth. With practice one acquires a certain degree of confidence in this determination. If the ventricle is enlarged from hydrocephalus, it will be even more easily reached and usually at less depth. When neither ventricle can be *reached* by properly directed punctures, it is strong evidence that hydrocephalus is not present, and this will at once signify that the tumor cannot be in the cerebellum, third ventricle, or brain-stem. When the ventricle is entered, it is usually not possible to say more than that the ventricle is not dislocated. Whether the ventricle is of normal size or enlarged, can be determined only by *measuring* the fluid which it contains. If only a few drops of fluid escape from the needle, the ventricle may be considered smaller than normal, but attempts to aspirate will always make this deduction safer. Occasionally, neither ventricle can be reached in the normal position, but one or both may be entered at a distance to the right or to the left. Such a displacement, when definite and particularly when known to be the same on both sides, can be explained only by the effects of a tumor; and the tumor must be on the side *from* which the dislocation has occurred. If the lateral deviation of the ventricles has been shown by a *posterior* ventricular puncture, it is presumptive evidence of a tumor in the *posterior* half of the cerebral hemisphere, for tumors in the anterior half of the hemisphere will hardly cause such a pronounced dislocation of the vestibules of the lateral ventricles. Doubtless more and greater deviation of the anterior horns would be demonstrable by puncture of the anterior horns, but the evidence of dislocation of the ventricles from a puncture is far less important and less reliable than the computation of the size of the ventricles. In one of our cases, however, the sole information of the tumor's position was learned from the dislocation of the ventricles (Case 4). Both lateral ventricles were so small that no fluid could be aspirated but each ventricle was reached far to the right of its normal position.

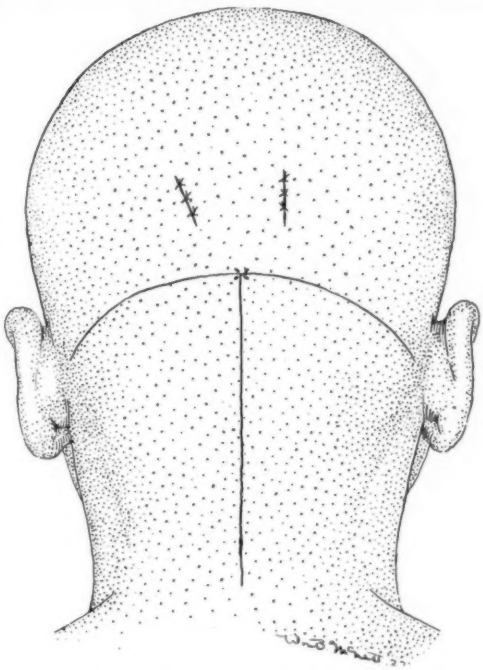

Fig. 1. To show the position for bilateral ventricular punctures. A cerebellar incision is outlined for orientation. For the puncture, either a slight oblique or ventrical incision can be made.

SIZE OF THE LATERAL VENTRICLES

From a large series of ventriculograms it has been found that the size of the normal lateral ventricle is most variable. Indeed, to differentiate between a large normal, and a small hydrocephalic, ventricle, often requires close study. But apparently the lateral ventricles in the same patient are of equal size unless there is some lesion to cause inequality.

We have also learned that the lateral ventricle is always smaller on the side of a cerebral tumor (excluding a resultant localized hydrocephalus) than on the opposite side and usually the difference is very striking. Indeed, the ventricle on the side of a tumor is usually so small that it cannot be reached by a ventricular puncture or, if reached, only a few drops of fluid will escape. Occasionally, as in one of the cases reported here, the size of both ventricles may be tremendously reduced, but usually there is a considerable difference in their size. For this reason, if we find one lateral ventricle from which 25 cubic centimeters of fluid can easily be aspirated. and

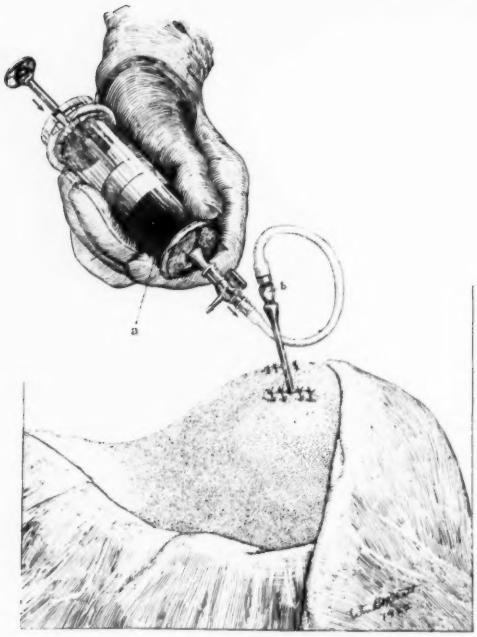

Fig. 2. To Show method of ventricular puncture and aspiration of the ventricle and injection of indigocarmin (a).

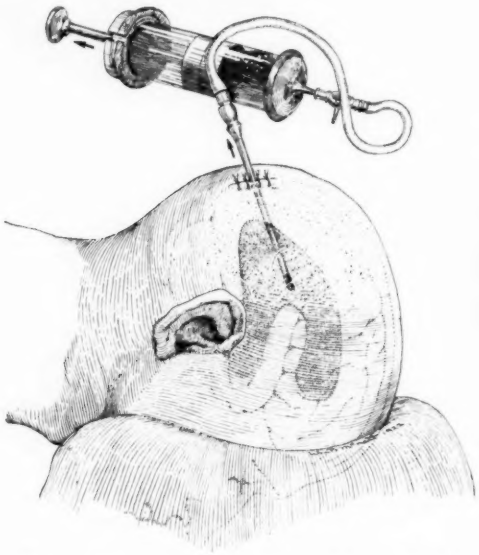

Fig. 3. Diagram, with lateral ventricles outlined, indicating the approximate course of the ventricular needle.

only 1 or 2 cubic centimeters can be obtained from the other ventricle, we may feel fairly confident (after excluding a block in the ventricle) that the tumor is on the side of the small ventricle. Again, if we can easily aspirate 25 cubic centimeters of fluid from a lateral ventricle, it is fairly safe (there are exceptions) to assume that a tumor does not exist in that hemisphere, for such a tumor would by this time have consumed that space in seeking room for expansion (we are now considering only patients in coma or with coma impending). And if both lateral ventricles are of equal size, it would be fairly safe to assume the presence of hydrocephalus and, therefore, that the tumor is in the cerebellum, brain-stem, or third ventricle. For practical purposes, we have come to look upon the aspiration of 25 cubic centimeters of fluid as a standard quantity upon which to draw conclusions. The aspiration of more fluid would usually require the injection of air to prevent too much negative pressure. In this connection, it should be emphasized that any conclusions drawn from the amount of fluid obtained by ventricular puncture alone, i.e., without aspirating fluid, are too capricious to be in any way reliable. The amount of fluid which spurts from a ventricular needle, except when the ventricle is very small, only indicates in a rough way the degree of intracranial pressure. From a ventricle of normal size or even smaller than normal, there will be a considerable spurt of fluid; a hydrocephalic ventricle may not give more. It is the reserve in the ventricle after the pressure relief which is important. A ventricle of normal size would exhaust its fluid in only partially relieving the intracranial pressure, and there would be no fluid in reserve for aspiration, but, from a hydrocephalic ventricle, additional fluid will still easily be obtained after the pressure has been relieved.

A small ventricle in one cerebral hemisphere will eliminate a tumor of the cerebellum, brain-stem, or third ventricle, but will not eliminate a unilateral hydrocephalus or focal hydrocephalus on the other side; and conversely, the demonstration of a hydrocephalus on one side does not prove a tumor to be in the cerebellum, brain-stem, or third ventricle.

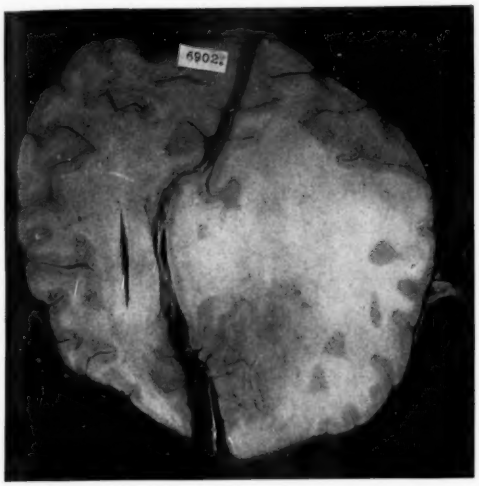

Fig. 4, *A*.

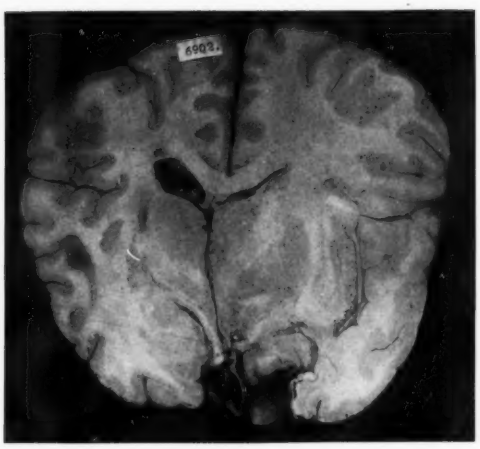

Fig. 4, *B*.

Fig. 4. *A* (at left), Shows the tips of the frontal lobes. The right hemisphere is dislocated toward the left by an abscess in this lobe. The increased bulk in this section is largely due to œdema surrounding the abscess, which is small. It will be seen that the anterior horn of the ventricle on the side of the abscess is absent and that the ventricle on the opposite side at this level is reduced to a slit. Doubtless the pressure of the bulging right hemisphere on the left pyramidal tract was the cause of the false localizing sign—right Jacksonian epilepsy. *B*, Section slightly posterior to *A*. The ventricle on the side of the abscess is still obliterated while the ventricle on the opposite side is approximately of normal size. The dislocation of the third ventricle and of the lateral ventricles, can also be seen.

It is never safe to draw conclusions from one lateral ventricle alone; the status of both ventricles must always be determined (Fig. 1); inferences from both still leave too many possibilities of error. It is hardly necessary to add that in drawing conclusions of such character, one must be very confident of his ability to reach a normally placed ventricle; also that some extraneous factor such as a plugged needle is not causing erroneous deductions to be drawn.

COMMUNICATION BETWEEN THE VENTRICLES THE INDIGOCARMIN TEST

An additional method of ventricular estimation is most useful in further reducing the chances of error in those cases in which the tumor has caused hydrocephalus. If 1 or 2 cubic centimeters (depending on the size of the ventricle) of indigocarmin[1] is injected into a lateral ventricle, aspiration of the contralateral ventricle will easily indicate whether or not the two lateral ventricles are in free communication (Figs. 2 and 3). If the dye does not pass from one ventricle to the other, there must be a tumor in the anterior or the middle and not the posterior cranial fossa. If both ventricles are dilated and the dye passes freely to the opposite side, the tumor will be in the posterior cranial fossa. Exceptions to the latter assumption are some pineal tumors and also those long-standing cases of hydrocephalus where an artificial communication between the lateral ventricles has resulted from pressure atrophy of the septum pellucidum; these atrophic openings have assumed this function of the foramina of Monro. This dye test is also useful in deciding whether the lateral ventricles communicate with the cisterna magna or the spinal sub-

[1] We formerly used phenolsulphonephthalein for this test but if quantitative determinations are not necessary, indigocarmin will do just as well. Apparently it is not irritating, whereas phenolsulphonephthalein, even when carefully prepared, may be very decidedly so.

For some time we have injected indigocarmin into a lateral ventricle as a routine procedure in all cases where a cerebellar operation is performed for tumor. It gives a striking objective demonstration of the location of the tumor, for the dye will not appear until the obstruction has been reached and passed and, if by chance the hydrocephalus is not due to tumor, the pressure of the dye in the cisterna magna will be excellent proof.

arachnoid space. At times it may be uncertain whether the lateral ventricles are hydrocephalic or merely of large but yet normal size. Again, the ventricles may be hydrocephalic but it may not be clear whether a tumor or another condition is responsible, i.e., whether the hydrocephalus is due to an obstruction or to an increased production of fluid. If an obstruction (usually a tumor) is the cause of hydrocephalus, the dye will not appear in the cisterna magna or the lumbar subarachnoid space. If the hydrocephalus is due to an increased production of cerebrospinal fluid (cardio-vascular-renal; chronic inflammatory reaction, etc.), the dye will freely pass into the cisterna magna or the spinal subarachnoid space. This communication or obstruction can be determined by aspiration through a lumbar puncture or a cisternal puncture (Ayer's puncture) or by operative exposure of the cisterna magna. We are strongly prejudiced against lumbar punctures in all cases where intracranial tumor is suspected, because of frequent medullary injury; except where intracranial pressure is first relieved by ventricular puncture, it should never be done and even then we would be most hesitant when a patient is in coma. Ayer's puncture would be at least equally dangerous for the same reason and also because the cisterna magna will always be obliterated by tumors in the posterior fossa. In cases where there is doubt and a tumor of the posterior fossa seems a probability, it is much safer to expose the cisterna magna. If the tumor is present, the operative procedure is necessary and if not present, we have erred on the safer side and done no harm. Uncertainty of this kind must be rare, but one such example recently came to our attention and will later be considered in some detail (Case 5).

The possibilities of this method developed during an exploration of the left cerebral hemisphere in a patient in deep coma from intracranial pressure.

A few hours after his arrival at the hospital, patient suddenly became unconscious. Fairly satisfactory examinations were made by Drs. Boggs and Thomas. The presence of an intracranial tumor or abscess was known because of the headaches, torpor, vomiting, and bilateral choked disc. There were, however, no positive localizing neurological findings except Jacksonian convulsions beginning in the right hand, spreading over the *right* side and eventually becoming bilateral. This history seemed sufficient to indicate a left cerebral lesion and this side of the brain was explored. In view of a history of sudden pain in the frontal region (bilateral), high fever for 3 weeks, swelling and closure of the *left* eye, immediately preceding patient's present illness, it was thought likely by both Drs. Thomas and Boggs that the lesion might be an abscess rather than a tumor. It should also be noted that the left pupil was much larger than the right. There had never been any localization of the headaches. He had had many convulsions while at home but in none had any focal character been observed. It was during examination in the hospital that the Jacksonian attack was seen. There was no motor or sensory inequality and the reflexes on the two sides were equal; no Babinski or ankle clonus on either side. There was bilateral choked disc of 6 diopters. The X-ray examination was negative. There seemed little doubt that the lesion was on the left side. Before beginning the operation, characteristic Cheyne-Stokes respirations developed and his color was cyanotic. Feeling that, should a tumor be found, his condition would not warrant its removal, only a decompression was planned, but in such deep coma the ordinary sized decompression would have been of little value. It is our custom in such extreme coma quickly to turn down a small bone-flap on the suspected side of the tumor. The operation can be done as quickly as the usual subtemporal decompression, and it has two great advantages: (1) it allows us to obtain very valuable information of the character of the tumor, thereby giving additional possibilities of treatment, and (2) if the tumor is found to be inoperable, all or part of the bone-flap can be removed, giving a larger and more effective decompression. At times a cyst may be encountered and its simple evacuation will give far more effective relief than any form of decompression alone. Ofttimes the patient's condition is sufficiently good to permit complete extirpation of a favorable tumor even at this operation. At other times an enucleable tumor may be encountered but the patient's condition may be too poor to permit its removal at this time but at a subsequent stage. Partial or total removal of the bone-flap will serve as a decompression until a succeeding stage. Experience alone can decide whether a one-stage or two-stage operation should be done in such emergencies. The general condition of each patient must be the guide in each. Always the one-stage operation is preferable, other things being equal, but tumor extirpations are such tremendous undertakings that it is always better to err on the side of safety and, when the patient's condition is not the best, to reserve extirpation for a second stage.

According to the above plan of treatment, a small bone-flap was quickly reflected on the left. A very

tense dura was exposed and incised concentrically. No anæsthetic was given at any time during the operation. The brain was allowed to protrude slowly through the dural defect and a big cerebral herniation bulged through the dural defect. No abnormality of any part of the cerebral cortex could be seen or palpated. The configuration of the lateral ventricle could easily be mapped out throughout practically its entire extent, a finding which usually denotes a large ventricle. A ventricular needle was passed into the vestibule of the ventricle and 25 cubic centimeters of fluid was aspirated. It contained 21 cells, suggesting that the lesion was probably an abscess. After release of the fluid, the outline of the ventricle was sharply shown by the indentation of the sunken cortex. The bone-flap was removed and the galea and skin quickly closed. These findings were interpreted as follows: with a ventricle so large, a tumor could not exist in this hemisphere and particularly as the enlargement was of the entire ventricle and not of a portion only. But it seemed possible from this data alone, to tell even more than merely to exclude this hemisphere as the seat of the tumor. When this ventricle was emptied there still remained intracranial pressure, i.e., there was still a big hernia of the brain through the dural opening. If the tumor were in the cerebellum or the brain-stem, there would be a bilateral hydrocephalus and after a puncture with aspiration of the fluid in this ventricle, the pressure in both cerebral hemispheres would be equally released, at least sufficiently to allow the brain to sink below the level of the dura, thus making the intracranial pressure negative instead of positive. We were, therefore, forced to conclude that a tumor mass must exist in the other (right) cerebral hemisphere; that the hydrocephalus (if such it was) must be confined to the side of operation and therefore be unilateral. The unilateral hydrocephalus must be due to closure of the third ventricle and the foramen of Monro on the operated side.

No benefit resulted from the decompression and the patient died on the following day. At necropsy an abscess of the *right* frontal lobe was found (Figs. 4a and 4b). We had operated on the *left* side because of a Jacksonian convulsion beginning in the right hand! Had his condition warranted air injection, the location of the abscess could have been easily determined. The misplaced confidence in the Jacksonian attack need not concern us here. We are merely warned that apparently positive signs are not always reliable. Had the operation been performed on the side of the lesion, allowing drainage of the abscess, a better result might conceivably have followed, even in his extreme condition.

During the past 6 months four other patients[1] have entered the Johns Hopkins Hospital in a comatose condition due to intracranial tumor and in whom no information leading to the location of the tumor could be elicited either from the history of friends and relatives or from the purely objective examinations of the comatose patients. In three of these patients the estimation of the ventricular capacity alone made the localization of the tumor possible. In the fourth, both lateral ventricles were so reduced that only drops of fluid could be obtained from either side, but the ventricles were so definitely dislocated toward the right that the tumor was localized to the left cerebral hemisphere. Two of these patients are now cured after total extirpation of dural endotheliomata. A third died 24 hours after total removal of a cerebello-pontine angle tumor and the fourth died of ventricular hæmorrhage 2 days after extirpation of a glioma which projected into the ventricle. Three were completed in one stage, the fourth in two stages. Possibly a two-stage operation would have been wiser in the two patients who did not recover.

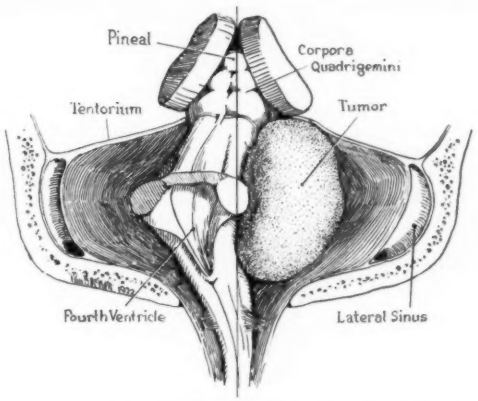

Fig. 5. Diagram of cerebello-pontine tumor located in Case 1 by ventricular estimation. The tumor has blocked the aqueduct of Sylvius causing symmetrical dilatation of the lateral ventricles; free communication between them is determined by the injection of indigocarmin into one ventricle and aspiration of the color in the other.

CASE 1. *Patient comatose. Diagnosis: Brain tumor. Presumptive localization: Left cerebral hemisphere. Localization following ventricular estimation: Tumor in posterior fossa. Operative finding: Tumor right cerebello-ponline angle. Total removal; death 18 hours later.*

[1] Other comatose patients afflicted with brain tumors have been operated upon during this period, but they have had signs which have indicated the location of the growth. The cases here reported are all in whom the procedure has been used since its adoption.

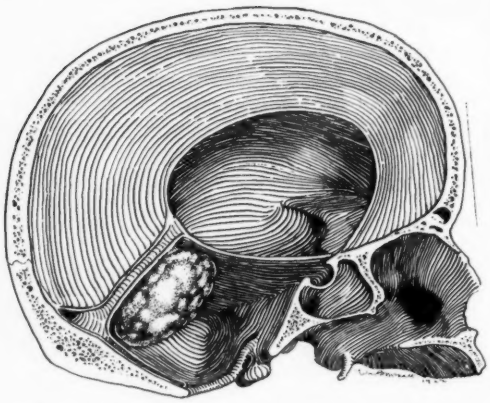

Fig. 6. Diagram to show position of dural endothelioma arising from the inferior surface of the tentorium cerebelli (Case 2). Dilatation of the lateral ventricles with free communication was determined by the ventricular estimation test. The cause of the hydrocephalus was obstruction of the aqueduct of Sylvius.

A sparely nourished woman, age 48, was seen in consultation in another hospital. For several hours she had been deeply unconscious following a lumbar puncture.

Over a period of 4 or 5 years she had complained of general headaches, perhaps greater over the vertex. These gradually increased in frequency and severity, and throughout the past 8 weeks were almost intolerable. At times, vomiting followed the severe headaches and gave a certain amount of relief. The right eye had been blind for 3 weeks, and only light perception remained in the left. During the past few weeks she had complained of a weakness of the right arm and leg. A slight facial asymmetry and weakness of the right arm had been noticed by her husband. Recently she fell when the right knee gave way. There had also been pain in the right arm at times. She had never complained of deafness or any unusual feeling in her face (involvement of nerves VIII and V). She was so deeply unconscious that the examination was entirely objective; except for a bilaterally symmetrical choked disc of 6 diopters, there was no positive neurological finding, though possibly the right side of the face moved less on deep stimulation of the surpra-orbital nerve; but the difference was not sufficiently definite to be considered positive. The reflexes were equal. There was no Babinski or ankle clonus on either side. No extra-ocular palsies could be detected; she had never complained of diplopia. The spinal fluid made at the above ill-advised lumbar puncture, contained globulin and a 4+ Wassermann. The blood pressure was 168-122; pulse 120. The diagnosis of an intracranial tumor was clear, owing to the bilateral choked disc, the long history of headaches, vomiting, and gradual loss of vision. The localization of the tumor was not clear, but from the history of weakness of the entire right side, a presumptive diagnosis of a left cerebral tumor, possibly frontal, was made. She was, therefore, draped for an exploration of the left cerebrum, but since the diagnosis was only tentative and based on the history, puncture of both lateral ventricles was first made to confirm or contradict this diagnosis. Twenty cubic centimeters of fluid was easily aspirated from each lateral ventricle and more could have been withdrawn. Indigocarmin injected into the left ventricle was quickly recovered when the right was aspirated. Such large ventricles were considered proof that our presumptive diagnosis was incorrect; that a tumor could not be present in either cerebral hemisphere and, since there was free communication between the ventricles, the neoplasm was probably in the posterior cranial fossa. The patient was then redraped for a cerebellar operation. The usual bilateral cerebellar exposure was made. A characteristic encapsulated tumor presented in the right cerebello-pontine angle (Fig. 5). Realizing that a cerebellar decompression would hardly be helpful, since the obstruction to the iter was caused by a firmly imbedded tumor which would not be affected by the removal of bone, an intracapsular enucleation was considered the only possible method of producing palliation. This was easily performed, but since her condition had remained unchanged, the removal of the capsule also seemed possible with little extra time and effort. It was, therefore, completely extirpated. There was no bleeding at any time, the individual arteries and veins being caught in silver clips. Consciousness did not return following the operation, death coming 18 hours later. In retrospect, it doubtless would have been wiser to have been content to leave the capsule in place and to complete its removal at a subsequent stage, particularly as the slightest injury to the medulla would greatly add to her danger. It is worthy of passing note that the Wassermann (4+) was of no significance and might have been very misleading.

CASE 2. *Patient comatose. Diagnosis: Brain tumor. Presumptive localization: Tumor of left cerebellum or right frontal lobe. Localization from ventricular estimation: Tumor in posterior fossa. Two-stage operation: Total removal encapsulated dural endothelioma arising from tentorium cerebelli. Recovery.*

A well nourished woman of 55 years was seen in Rochester, New York, in consultation with Dr. John R. Booth. For the past 2 days she had gradually become increasingly drowsy and during the night lapsed into coma. Although no response to questions was obtainable, she still moved at times. Though the wife of a physician, she had complained so little that he could offer nothing which was helpful in making a localization of her lesion. For only the past 2 months had she complained of general headaches, intensified by defæcation. Frequently there was vomiting. For a few days there had been diplopia but this had disappeared. For 5 weeks there

had been dizziness and an uncertain, unsteady gait with possibly a tendency to deviate to the left. At times she had spoken of a weakness of the left leg and arm, but nothing suggesting ataxia or nystagmus had been observed. A severe acute infection of the right frontal sinus had immediately preceded her headaches, and this had been looked upon as the cause of her present illness. Except for a choked disc of about 7 diopters in each fundus oculi, the examination was entirely negative. No nystagmus could be elicited; there was no noticeable strabismus. No difference in the muscle tone of either arm could be detected on quickly flexing and extending the forearm. The reflexes were normal and equal on the two sides. No Babinski or ankle clonus. White blood count, 15,000; pulse, 120; temperature, 99.2°. There was little evidence upon which to differentiate between a right frontal tumor or abscess and one in the left cerebellum. The strongly emphasized frontal infection (sinuses now clear), the leucocytosis of 15,000, and the history of a weakness of the left side, were weighed against a possible history of staggering gait and tendency to fall to the left.

She was at once brought to Baltimore and sent directly to the operating room. She stood the journey surprisingly well, there being very grave doubt that she would reach the destination. The operation: 25 cubic centimeters of fluid was aspirated from each lateral ventricle. It was under great pressure. The reasoning from these data was essentially like that in the preceding case. Ventricles of such size were considered incompatible with a tumor in either cerebral hemisphere and indicated an infratentorial tumor. A bilateral cerebellar decompression was made. The left lobe was so much larger than the right that a tumor in the left cerebellar hemisphere was unquestioned. A cyst was excluded by a puncture of the hemisphere. No attempt was made to learn more about the tumor because of her desperate condition. During the next few days consciousness returned and her strength quickly followed. Had we been able to consult the patient, the differential diagnosis would not have been difficult. The staggering gait and tendency to fall to the left had not been equivocal. She had been very dizzy for some time and because of this had been unwilling to lie on the left side. She had not communicated these symptoms to her husband because of her unwillingness to worry him.

A month later, an encapsulated dural endothelioma weighing 40.5 grams (Fig. 7) and arising from the inferior surface of the tentorium (Fig. 6), was removed *in toto*. It was completely hidden from view by the overlying left lobe of the cerebellum so that it was not actually seen at the first operation. She made an uneventful recovery.

CASE 3. *Patient comatose. Diagnosis: Brain tumor. Localization not presumed. Localization after ventricular estimation: Right occipital lobe. Operation: Removal dural endothelioma arising from superior surface of tentorium. Recovery.*

Fig. 7. Drawing of the tumor shown in diagram (Fig. 6). An uneventful recovery followed its removal. Weight of tumor 40.5 grams.

Patient is a well-nourished woman, age 50; referred by Dr. J. S. Horsley of Richmond, Virginia. On arrival at the Johns Hopkins Hospital she was unconscious and had been so for about 5 hours. Only very deep stimulation of the supra-orbital nerve brought response. Respirations were of the typical Cheyne-Stokes type, with breathless intervals of 40 seconds; pulse slow, full, and bounding, 60 per minute. Her present trouble began only 3 months before admission, with severe headaches on the top of the head—never more localized. In the beginning the headaches would last 2 or 3 hours and recur two or three times a week. Gradually they increased in frequency and severity and for the past month they have been almost constant. There was some pain and tenderness in the back of the head and some stiffness of the neck. She became dull and slept a great deal. Nausea and vomiting began about a month after the onset of headaches and for 2 days during the last week she vomited almost continuously. Two weeks before admission her eyes became crossed. About this time she also saw half of things, but her physician could find no hemianopsia. Dr. Horsley and Dr. Vaughan saw her for a few hours and apparently made out a hemianopsia to the left, but, as Dr. Horsley's notes had not yet arrived, our only information about the hemianopsia was brought through the husband. We had no way of knowing how definite this finding might be.

The examination showed a paralysis of the *left* external rectus (Fig. 10), the eye being turned strongly inward and a bilateral choked disc of 6 diopters. There were no differences in the reflexes on the two

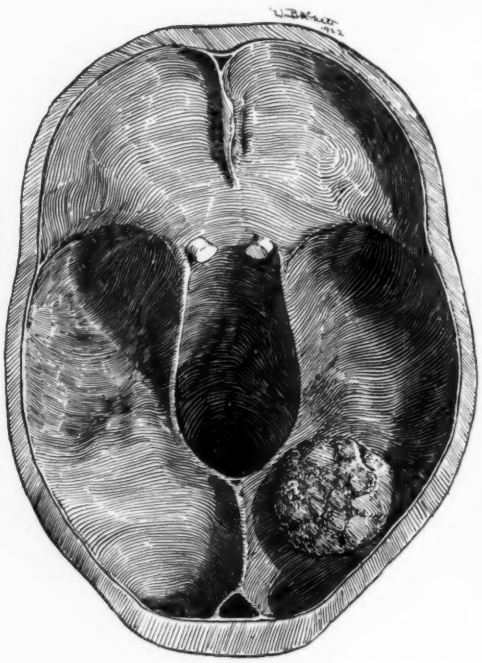

Fig. 8. Diagram to show the position of the dural endothelioma arising from the superior surface of the tentorium (Case 3). It was located by the ventricular estimation test. The tumor was completely removed; uneventful recovery.

sides, no Babinski or ankle clonus. No difference in the muscle tone could be detected. The one objective finding, therefore, was paralysis of the *left* external rectus muscle (nerve VI). The possible history of a hemianopsia to the left would not harmonize with palsy of the left nerve VI, but the value of implication of the sixth nerve is too capricious to be taken seriously. Here we should have been misled had it been considered a localizing sign. The suboccipital headache and cervical rigidity suggested the possibility of a cerebellar tumor, though no history of staggering gait could be elicited.

Bilateral ventricular punctures were attempted; the right ventricle could *not* be reached, the left ventricle was encountered in a position which did not appear abnormal, but only 10 cubic centimeters of fluid could be withdrawn. Again an attempt was made to reach the right ventricle, but again without success. We were safe in excluding a tumor of the posterior cranial fossa because there was no hydrocephalus. The inability to reach the right ventricle was presumptive evidence of a tumor on this side, especially when taken in conjunction with a fairly normal sized ventricle on the left, and if the tumor was on the right it would more probably be located posteriorly because of the closure of the posterior horn and vestibule; this part of the ventricle would hardly have been completely occluded, or at least it would have seemed less likely, from a tumor located anteriorly in the hemisphere. A presumptive diagnosis was then made of a tumor of the occipital lobe. Operation: A bone-flap was turned down exposing the posterior two-thirds of the right cerebral hemisphere. The brain under high tension quickly herniated through the dural opening. No tumor was visible, though practically the entire outer surface of the brain could be inspected. Posteriorly, however, the brain was distinctly paler than elsewhere, the convolutions were wider and the sulci so flattened that they were practically devoid of the normal mantle of cerebrospinal fluid; all of which indicated an underlying tumor. The inferior tentorial surface of the occipital lobe was then explored and about 1 centimeter beneath the outer surface, a well-rounded edge of tumor presented. A perfectly encapsulated dural endothelioma was gradually brought into view and totally extirpated without unusual difficulty. It weighed 22 grams (Fig. 9). Recovery uneventful.

CASE 4. *Patient comatose. Diagnosis: Brain tumor. No localization presumed. Localization after ventricular estimation: Left cerebral hemisphere, probably occipital. Operation: Removal deeply situated subcortical glioma projecting into the lateral ventricle. Death 2 days later of intraventricular hæmorrhage.*

Patient was a well-nourished woman of 37. When first seen with Dr. L. A. Krause, she was extremely restless but unresponsive. In the interval of about an hour before reaching the hospital, she became so deeply comatose that strong supra-orbital pressure brought no response. She became cyanotic and respirations were very shallow and pulse which had been 60 to 70 quickly mounted to 140. When placed in the ventral position there was some improvement, which became so great when a ventricular puncture was done as to allay immediate apprehension and allow us to proceed with the operation.

Her history and examination were easily adequate to make the diagnosis of an intracranial tumor. Although she had suffered from headaches nearly all her life, they had become much more severe 4 months ago and had since been practically constant. The headaches have been frontal, at the vertex and occipital regions, but never confined to one side. About 4 months ago blurring vision was noticed; this became so bad that she could not read the music notes (she was a music teacher). Double vision was present at times. There had been no complaint of hemianopsia. The vision in the left eye seemed worse than the right. To see objects with her left eye, she would be compelled to turn her head around in this direction. (This was considered at the time as possible evidence of hemianopsia; the tumor's location, however, would have caused homonymous hemianopsia to the right instead of to the left).

Vomiting spells had been frequent, sometimes four or five attacks a day. Nausea was present most

Fig. 9. Drawing of tumor shown in diagram (Fig. 8). Weight 22 grams.

Fig. 10. Showing patient (Case 3) from whom preceding tumor (Fig. 9) was removed. This photograph shows the contralateral abducens palsy which still persists at the time this photograph was taken, 3 weeks after operation.

of the time and caused great distress. A month before admission she became unconscious and remained so for an hour, but is said not to have had a convulsion. Dr. Krause, who saw her for the first time only 24 hours before my examination, made out more active reflexes on the right, but no other changes. The reflex difference was not evident when I saw her. No Babinski and no ankle clonus were present. A bilateral choked disc of 6 or 7 diopters was the only positive finding.

Attempts were made to tap both lateral ventricles but at first neither could be reached. The right ventricle was finally entered, probably 2.5 centimeters to the right of its proper position (as nearly as could be estimated from the deeply concealed tip of the needle), but only a few drops of fluid escaped and apparently under no increased pressure (when ventricles are so greatly reduced in size, the few drops of fluid which escape from the needle indicate a cavity too small to register intracranial pressure). The left ventricle was also reached far to the right. It was so compressed that no fluid escaped through the end of the needle; the only proof that the left ventricle had been reached was a few drops of clear fluid which escaped from the needle after its withdrawal. The diagnostic reasoning from these observations was as follows: the lesion could not be in the posterior fossa because there was no hydrocephalus; it was probably in the left cerebral hemisphere because both lateral ventricles were definitely dislocated to the right; the almost complete obliteration of the posterior part of both lateral ventricles, together with the great dislocation of this part of the ventricles, indicated that the location of the tumor was probably in the occipital region. Accordingly, the left occipital region was explored. Although no tumor was on the outer or inferior surfaces of the brain, an underlying lesion was indicated by the pallor and breadth of the convolutions and obliteration of the fluid-containing sulci. Transcortical exploration just back of the supramarginal gyrus disclosed a well-circumscribed tumor about 3 centimeters below the surface of the brain (Fig. 11). The position of the tumor would indicate a probable glioma, but it was extremely hard—almost of stony consistency—and seemed to separate readily from the brain tissue; moreover, a large, smooth nodule projected into the vestibule of the ventricle. For these reasons, the possibility of an ependymal tumor was considered. The most distant parts of the tumor became increasingly more fixed and less circumscribed; it was then clear that the tumor was a glioma and could not be completely removed, unless possibly after removing the main mass of tumor the outskirts could be excised later with normal brain tissue. A tumor mass weighing 105.5 grams (Fig. 12) was removed with considerable difficulty by finger enucleation leaving of course fringes of the tumor, even though invisible. The vestibule of the ventricle was opened. The bleeding was controlled after a large vein entering the vena Galena magna had been ligated. After removal of the tumor the incisura tentorii was in plain view, in fact it was here that the large bleeding vessel was "clipped." The glomus of the choroid plexus was exposed in the open ventricle. The bleeding was apparently entirely checked for some time before closure; but the possibility of a tiny ooze into an open ventricle is always the source of apprehension. Two days later she died of intraventricular hæmorrhage.

POSSIBILITIES OF ERROR FROM VENTRICULAR ESTIMATION

It is well to reiterate that there are great possibilities of error in this procedure for reasons which we shall show. It is justifiable

to disregard these possible mistakes only when the patient's condition is so serious as to preclude cerebral pneumography or when there is only a slight element of doubt of the location of the tumor which may be eliminated in this way. The whole procedure, of course, is dependent upon knowledge of ventricular topography, upon the confidence in one's ability precisely to reach the normal ventricle and in the interpretation in terms of intracranial pathology of the results of the punctures.

The first element of uncertainty lies in the great variation in size of the normal lateral ventricles. A lateral ventricle in one individual may be 4 or 5 times as large as in another. A big normal lateral ventricle may even be larger than a small hydrocephalic ventricle. From a small lateral ventricle 10 to 15 cubic centimeters of fluid can usually be aspirated, but from ventricles apparently equally normal 30 to 40 cubic centimeters may be obtained, and there are all sizes between. It is evident, therefore, that large normal ventricles may easily be mistaken for hydrocephalic ventricles, if ventricular estimation alone were depended upon for a localization of the growth. There would really be no way of making the differentiation by this method. In order to emphasize this danger, the following case in point is briefly presented. Had this patient been comatose at the time of entrance to the hospital, and if his localization had depended on ventricular estimation, doubtless a cerebellar operation would have been performed and his tumor would have been missed.

This patient was blind from intracranial pressure but had absolutely no signs of the tumor's location. The accompanying ventriculograms indicate the location of the tumor and oversize of the lateral ventricles—surely normal for this individual and not increased in any conceivable way by the tumor's pressure. Despite the great size of the tumor—143.5 grams—a dural endothelioma (Fig. 16)—this ventricle still yielded 30 cubic centimeters of fluid, an amount which would easily indicate a hydrocephalic ventricle. The tumor was completely enucleated and an uninterrupted recovery followed.

It will be seen from these ventriculograms (Figs. 13, 14, and 15), that the tip of the posterior horn extends so nearly to the surface of the brain that the ventricular needle would have to penetrate only about 1 centimeter of brain tissue to reach it. Such a finding could easily lead to the assumption that the ventricle was greatly dilated.

Probably an even greater element of error in the use of this method is in cases of hydrocephalus. Bilateral hydrocephalus may develop from tumors of the pituitary, third ventricle, pineal body, cerebellum and brainstem, or more precisely from tumors which can produce an obstruction anywhere between the foramina of Monro and the foramen of Magendie, i.e., roughly about three-quarters of the longitudinal extent of the brain. From the interpretation of the findings of ventricular estimation as just described, on the law of probability the tumor would be in the posterior cranial fossa, but a very high percentage of cases with bilateral hydrocephalus are in the middle and not the posterior cranial fossa. Tumors of the pituitary, third ventricle, and some tumors of the pineal body, can be eliminated by the indigocarmin test. The elimination of these growths (of ever-increasing importance) reduces the chances of error to the small group of tumors of the pineal and of the contiguous part of the brain, i.e., those tumors which occlude the aqueduct of Sylvius but do not close the foramina of Monro. From a practical standpoint, however, the chance of curing or even temporarily relieving a patient in coma from bilateral hydrocephalus when the tumor lies elsewhere than in the posterior cranial fossa is slight. In the presence of a *bilateral* hydrocephalus, the two lateral ventricles communicating, there is justification, from a practical standpoint, of a cerebellar exploration. And with the dye test, practically all tumors of the posterior fossa can be found at operation.

EXCLUSION OF TUMORS BY VENTRICULAR ESTIMATION

Coma resulting from other intracranial lesions simulating tumor—chronic meningitis. At times other conditions may produce coma which is very difficult or even impossible to

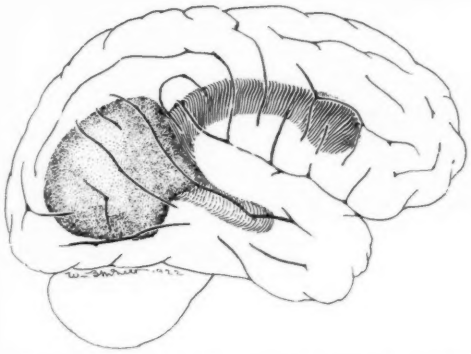

Fig. 11. Diagram showing position of tumor in occipital lobe (Case 4) located by ventricular estimation test. Tumor, which was a glioma, projected into the lateral ventricle. Patient died 2 days later of a slow bleeding into the ventricle.

Fig. 12. Photograph of tumor from Figure 11 (Case 4). This tumor was not encapsulated and a permanent cure could not have resulted. The smooth area, *a*, is the intraventricular part of the tumor. Weight of the tumor is 105.5 grams.

differentiate from that of brain tumor. This is particularly true when coma is so far advanced that there is not time for extended examination. Such a case was recently seen in consultation with Dr. Horning of York, Philadelphia.

The patient, a large, strong man of 55 years, had been in partial coma for 48 hours. He was then deeply unconscious, though deep supra-orbital pressure brought response. The respirations were characteristically of Cheyne-Stokes type. Until 2 weeks ago, he had seemed well in every way. Bifrontal headaches beginning at that time quickly became so severe that he was forced to bed. The headaches had been practically constant and of steadily increasing intensity. When he attempted to walk his gait was like that of a drunken person and unless supported he would fall. A squint appeared about a week ago. Urinary and fecal incontinence developed with coma. A choked disc of 4 diopters completely obliterated both nerve heads. Pulse 70; temperature 99.6°; blood pressure 185-100. The urine contained a few cells and more than a trace of albumin. On two examinations previously made by Dr. Horning, a trace of albumin was found. Left cardiac dullness extended 13.5 centimeters from the midline; the heart sounds were clear. There was no œdema of the eyelids or ankles. Aside from a slight abducens palsy, the neurological examination revealed no positive findings. The reflexes were equal and normal, no Babinski or ankle clonus; no difference in the muscle tone of the two sides. There was no history of a blow on the head. There was no rigidity of the neck.

The cause of the coma was by no means clear. A cardio-vascular-renal syndrome was considered. The blood pressure of 185, trace of albumin and white cells in the urine, made a nephritic condition possible, but these findings did not seem sufficient for such profound intracranial as well as systemic changes. On the other hand, the history of headaches of only 2 weeks' duration before the onset of coma, is most unusual for an intracranial tumor. But all of his symptoms had been referable to the head, i.e., headache, staggering gait, and strabismus; these and a bilateral choked disc made an encephalopathy clear. A brain tumor seemed the most plausible explanation of all the facts in our possession and possibly a cerebellar tumor because of the staggering gait. But the evidence was not conclusive even that it was a tumor, largely because the history was too short and the symptoms and coma too fulminating (not impossibilities, however). Nor were we willing to make a positive localization to the cerebellum; staggering gait might be due to weakness, intensity of headache, or dizziness. Ventricular estimation tests showed both lateral ventricles large (25 cubic centimeters easily obtained) and indigocarmin easily passed from one ventricle to the other. The ventricular fluid was under pressure. If a tumor, it was therefore not in either cerebral hemisphere, but must be in the posterior fossa. If a tumor was in the posterior cranial fossa, the dye would not pass into the cisterna magna or the spinal subarachnoid space. A spinal puncture or an Ayer's puncture or exposure of the cisterna magna would determine the presence or absence of such a tumor. Because of the great danger of lumbar punctures and of Ayer punctures in intracranial tumors, we were forced for reasons of safety to a direct exposure of the cisterna. The presence of the dye in quantity precluded a tumor and made the diagnosis of hydrocephalus of the communicating type due to some condition other than a tumor. The cisterna magna was oversize and the cerebellar tonsils were not herniated into the foramen magnum. Both of these findings made a cerebellar tumor highly improbable. Hydrocephalus of this character is probably due to an increased production of fluid rather than to an ob-

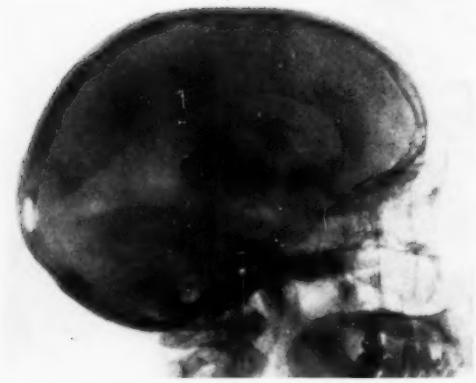

Fig. 13. Roentgenogram showing large left normal lateral ventricle in patient with dural endothelioma in the right frontal lobe.

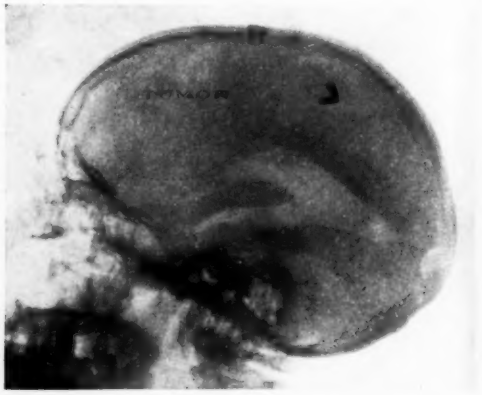

Fig. 14. Roentgenogram showing the right lateral ventricle deformed anteriorly by indentation of the superimposed dural endothelioma. See Figure 16.

struction with decreased absorption. Possibly in this case it may have been due to a cardio-vascular-renal syndrome, though this is by no means yet clear. Death came 30 hours later. A complete necropsy was made by Dr. MacCallum. He reports a mild chronic inflammatory process along the base of the brain. The condition was doubtless, therefore, a chronic meningitis of unknown origin. Bacteria were not found. There was no tumor in the brain. However, we are concerned here only with the diagnosis and elimination of the tumor.

SUMMARY OF CASES

About 6 months ago, a left craniotomy was performed on a patient in the terminal stages of coma from intracranial pressure, presumably due to a tumor or abscess. The sole means of determining upon which side the exploration should be made was a Jacksonian convulsion beginning in the right hand. Though considered a most trustworthy localizing manifestation, it proved misleading on this occasion, for at necropsy an abscess was found in the right frontal lobe, i.e., it was homolateral to the side of the convulsion. During the operation, information was gained from the lateral ventricle which led us to the adoption of a procedure which we may call "estimation of the cerebral ventricles." Its object is to localize growths in such emergencies. The information leading to this end is derived from a determination of the capacity, location, and intercommunication of the cerebral ventricles, particularly the lateral ventricles. Since this first case, five other patients have been seen in coma from intracranial pressure. In none of them was there any information obtainable, either from the history of friends and relatives or from the restricted objective examination of the unconscious patient, which was considered of merit in determining the location of the lesion. In four of these patients the lesion was a tumor and in the fifth an acute hydrocephalus of chronic meningitis origin. In the last case, a tentative diagnosis of tumor was made but given up as a result of the "ventricular estimation" tests. Possibly an analysis of the fluid at the time might have shown an increased cell count, but unfortunately this examination was not made because the fluid was blood-stained. The Wassermann from the ventricular fluid was negative. Each of the four tumors was correctly localized by these tests and in each instance the tumor was found at operation and removed. Two of these patients succumbed on the following day and the other two, after complete removal of dural endotheliomata, recovered and are now entirely well.

SUMMARY OF REASONS FOR VENTRICULAR ESTIMATION

Three determinations are made: (1) The position of the lateral ventricles by the ventricular puncture; (2) the size of each lateral

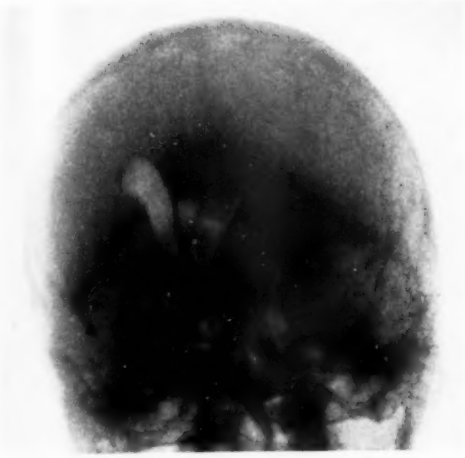

Fig. 15. Anteroposterior ventriculogram (of Figs. 13 and 14) showing the dislocation of both lateral ventricles to the left side and the marked deformation of the right ventricle from the superimposed tumor. These ventriculograms indicate large ventricles but which are still normal—a not uncommon finding. Had ventricular estimation tests been used on this patient, a cerebellar operation would doubtless have been performed and the tumor would have been missed. They are shown to emphasize the possibilities of error in this method.

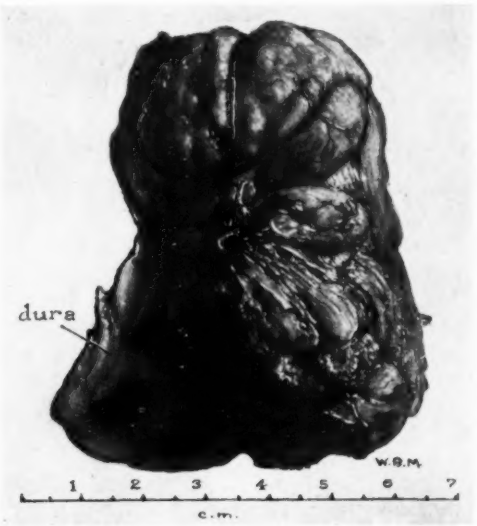

Fig. 16. This tumor was removed from the patient whose ventriculograms are shown in Figures 13, 14, and 15. Except for blindness which will be permanent, this patient is well.

ventricle by measurement of amount of ventricular fluid aspirated from each lateral ventricle; (3) the communicability of the lateral ventricles (or other parts of the cerebrospinal system) by injecting indigocarmin into a lateral ventricle and then aspirating fluid elsewhere (depending on part of the ventricular system to be tested).

If we know the actual size of each lateral ventricle, we can infer, with a certain degree of accuracy, whether a tumor can exist in either cerebral hemisphere. If one lateral ventricle is small (or collapsed) and the other larger, a tumor will probably be on the side of the small ventricle (with exceptions). If both lateral ventricles are large, a tumor will probably not be in either hemisphere but in the posterior cranial fossa (with more exceptions). The exceptions are principally instances in which hydrocephalus results from tumors in the middle or even at times the anterior cranial fossa. The indigocarmin test is principally useful in eliminating and identifying these exceptions. From its use we are usually able to say whether there is any obstruction in the ventricular system anterior to the aqueduct of Sylvius. An obstruction anterior to the aqueduct of Sylvius will (with exceptions) prevent the dye from passing from one lateral ventricle to the other. On occasions, which are probably not frequent, it is necessary to know whether an obstruction exists at or posterior to the aqueduct of Sylvius; this is almost equal to determining whether a tumor or some other condition is causing the coma. For information of this character, it is necessary to inject the dye and test for its presence in the cisterna magna (or spinal canal). It is safer to expose the cisterna magna by operation than to employ lumbar puncture. It is only when both ventricles are so nearly occluded that only a few drops of fluid can be obtained, that we are forced to rely solely upon the information from a ventricular puncture. A definite displacement of both lateral ventricles will then indicate the location of the growth. It is, of course, possible even with large tumors that there may be no dislocation, or at best it will not be sufficiently marked to draw any conclusions.

I have seen such a case at necropsy: a tumor arising in the midline had grown to each side and occluded practically all of the posterior three-fourths of both lateral ventricles. This in one of the situations in which the method is defective.

SUMMARY OF ARGUMENTS FOR AND AGAINST VENTRICULAR ESTIMATION

The method is relatively simple, easily performed, relatively harmless, and requires very little time. The principal danger to life is in puncturing an intraventricular tumor and thereby causing death from intraventricular hæmorrhage. Though this is always an actual danger, it is not deterrent when we consider the magnitude of the problem of saving an unconscious patient. It requires very little, and at times no extra, time, but the relief of intracranial pressure by release of fluid is more than compensatory. The greatest drawback is the possibility of an incorrect localization. Were it not for this very great element of error (described above), the procedure could be used as a substitute for cerebral pneumography. But the element of error is of such magnitude that the procedure should be used only in emergencies, where the more precise methods would add danger to an already overstrained intracranial tension. I am not so certain that in time it may not appear advisable to use it in cases of hydrocephalus, but at present this does not seem indicated. There are many instances where we could have made the correct localization of an intracranial tumor by this method and spared the patient discomfort and a certain degree of danger, but there are other tumors which would surely have been missed at operation had it alone been employed. The treatment of brain tumors is always too serious and too all-dependent on a precise localization, to run the risks of an incorrect operation based upon a mistaken diagnosis which has been made with even an element of chance or guesswork.

CRANIAL AND INTRACRANIAL ENDOTHELIOMATA—HEMICRANIOSIS

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INTRODUCTION

TUMORS of the type described in this paper were first called to my attention by Mr. Percy Sargent. It was my privilege to assist him in the removal of an intracranial tumor which was associated with a lump on the overlying cranium (see Case 9). After operation, the case was shown to the Neurological Section of the Royal Society of Medicine, February 10, 1921. This led me to search the records of the National Hospital for any other possible instances of the association of intracranial neoplasm with exostoses of the skull.[1]

The reports of 420 patients who had been proved to have brain tumors at operation or autopsy were examined. Ten cases were found to have a hard prominence of the skull which had been noted on admission. In each case the intracranial tumor was situated immediately beneath the prominence. In 8 of these cases, there was a report of microscopical examination, and the specimens from one of the remaining two cases were found and sections cut. (A case of sarcoma perforating the skull produced a lump on the cranium. It did not resemble this group because the lump was soft and could be pressed inward through the skull. It was therefore not included.)

Of the 9 cases with microscopical examinations, 7 were operated upon by Sir Victor Horsley and 2 by Mr. Sargent. To my surprise, all presented the same histological picture and similar clinical courses. They seem to form a definite variety of tumor which frequently should be diagnosed before localizing cerebral symptoms appear. The end-result of those cases that survived operation is very encouraging. For this reason it is important that this type of brain tumor should be generally recognized.

Nine similar cases with histological examinations of at least the *intra*cranial part of the tumor have been collected from medical literature. These include cases called hemicraniosis by French authors.

Case 1. H. P., a woman of 41, was admitted to the National Hospital, Queen's Square, London, in 1906, under the care of Dr. Risien Russell. There was no history of injury, but for 10 years she had noticed when she combed her hair, a steadily increasing "hard knot" on her head. For 12 months she had complained of headaches referred to this lump, and for 6 months very severe, darting and stabbing pains referred to the same location. These sharp pains came on two or three times a week, usually in the morning. For 6 months there had been attacks of giddiness and fainting. At these times "the room seemed to go around."

Dr. S. A. K. Wilson made the following note on her admission. "Small, poorly nourished woman. On the left side of head growing from cranial vault is a large, hard, rounded mass which passes insensibly into surrounding bone (see Fig. 1). It is covered with hair except anteriorly where the cutaneous veins of the scalp . . . are larger than is usual. The mass is absolutely hard and quite painless when knocked. Its situation is chiefly over the upper posterior part of the left frontal bone. Its circumference at the base is 14½ inches, the greatest coronal arc 6½ inches and the greatest sagittal arc 6⅜ inches." There was no lesion of the cranial nerves and physical examination otherwise presented no departure from the normal.

Operation by Sir Victor Horsley. A scalp flap was turned back, a trephine opening made at the side of the bony tumor, and a double cut made with a hand saw all the way round the growth. The mass was then broken free and forcibly removed, including a rim of what appeared to be normal calvarium. In the process of removal, the underlying dura which was thickened and discolored, was torn. It had been adherent to the concave surface of the bony tumor. The convolutions of the brain seemed perfectly normal. A drain was inserted and the wound closed. There was no subdural tumor after removal of dura.

Postoperative course. After the operation the patient's condition was critical and she became for a time aphasic. This rapidly cleared up, however, the wound healed perfectly and she left the hospital without any abnormal physical signs. May 13, 1921, 15 years after the operation, the patient was visited

[1] It is due to the generous scientific spirit of the attending staff at the National Hospital for Paralysed and Epileptic, Queen's Square, London, that this study is made possible. I am particularly indebted to Dr. Greenfield, Director of the Pathological Laboratory, for putting at my disposal specimens preserved in the museum, and for his advice and friendly help in preparing the material. It was thus possible to supplement the pathological reports and especially to decalcify and examine the bony tumors microscopically, many of which had not been so examined.

Fig. 1.

Fig. 2.

Fig. 1. Case 1. H. P. before operation. (Kindness of Dr. S. A. K. Wilson.)

Fig. 2. Case 1. H. P. in 1922, 16 years after operation.

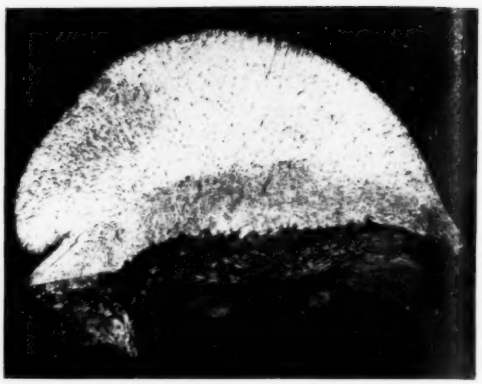

Fig. 3. Case 1. Infiltrated bone cut in half. The cut surface is 5 centimeters high by 9½ centimeters wide.

and the following postoperative story obtained. On returning to her home, a small village where her husband was a laborer, she was able to take up her work as well as formerly, and said she "had nothing the matter with" her. One year after the operation, she began to have "fits" in which her "face went crooked," she fell to the floor, foamed at the mouth, and had a general convulsion. These attacks became less frequent and 3 years before the interview they stopped altogether. Four years ago she became blind. In a personal communication, Dr. P. H. Adams of the Oxford Eye Hospital, who had examined her in 1917, states "she had undoubtedly had chronic glaucoma, which would account for the atrophy of the discs and blindness." She has complained of headaches beginning about a year after the operation. These headaches are most troublesome when she gets up in the morning. Stooping over brings on a headache and assuming an erect attitude relieves it.

Examination showed her to be an active elderly woman whose intelligence and speech, were normal (see Fig. 2). She was quite blind but moved about the room with considerable assurance. She is able

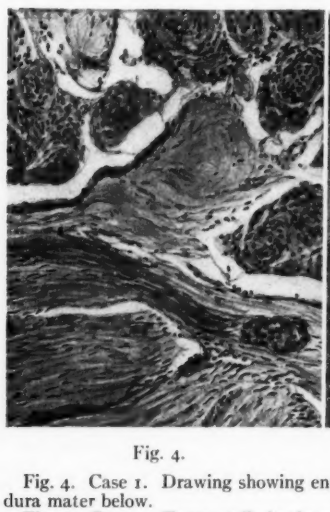

Fig. 4.

Fig. 5.

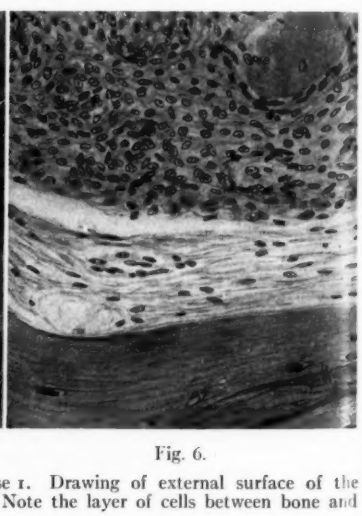

Fig. 6.

Fig. 4. Case 1. Drawing showing endothelioma above, dura mater below.

Fig. 5. Case 1. Tumor cells in the canals of the bone, which is everywhere eburnated.

Fig. 6. Case 1. Drawing of external surface of the cranial boss. Note the layer of cells between bone and neoplasm.

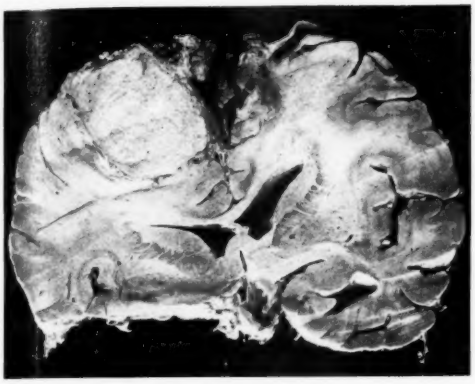

Fig. 7. Case 3. Circumscribed endothelioma attached to falx and encroaching on both hemispheres.

to do much of her work. Over the left frontoparietal region is a large area corresponding to the original removal of bone. There are some irregularities of the edges of the bony defect and at one point may be felt a rim with a shelving margin about 1 inch in width. The scalp over the defect is depressed and relaxed. Physical examination showed nothing abnormal in other respects.

Pathology. The tumor removed from the cranium at operation appeared to be dense bone. Its weight was 575 grams and greatest thickness 5¼ centimeters. It passed off into normal skull in places; in others, it overlapped the external table. After cutting through it with a saw (Fig. 3), the central part of the tumor was seen to be somewhat more dense bone than the normal skull. Part of the removed dura presented on "its outer surface a pinkish, gelatinous, tumour-like mass, a few millimeters in thickness."

Microscopic examination of this area of dura showed the whole membrane infiltrated with typical endothelioma, consisting of oval nuclei arranged in concentric whorls. Tumor was heaped up on one side of the dura. It is not certain which side. Figure 4 is a drawing of this area. The septa of the tumor seem to be continuous with the tissue of the dura. Pieces of the bony tumor were decalcified and stained (Fig. 5). To quote from the pathological report, it was apparent that "all the canals of the bone contained portions of tumour identical with that growing on the dura mater." Where the haversian canals were cut lengthwise, the endothelioma cells appeared as strands or columns. On the external surface of the bone there were numerous cup-like excavations which were filled with plugs of neoplasm. Figure 6 shows the surface of the floor of such a cup. Between neoplasm and bone is a layer of what appears to be connective tissue. If bone formation was in progress, as seems almost certain, it was taking place beneath this layer of cells.

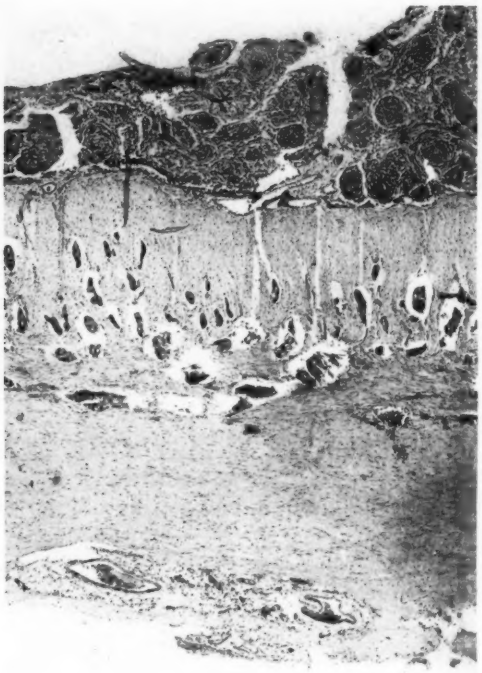

Fig. 8. Case 4. Endothelioma adherent to dura and passing through it. A connective-tissue septum may be seen attached to dura and passing through the neoplasm.

In *summary*, for 10 years the patient had had a gradually increasing horn-like tumor of the skull which reached the size of a baseball and which was composed of compact bone. The osseous canals were filled with cells identical with those infiltrating the dura beneath. These cells in form and arrangement resemble those of the usual dural endothelioma. Between bone and neoplasm may be made out a layer of cells resembling connective tissue. There was no large subdural growth in this case. The preoperative symptoms were headache and stabbing pain referred to the tumor and probably due to the effect of the growth on the dura. There were also attacks of vertigo.

After operative removal, complete relief of symptoms was followed by epileptiform attacks which disappeared. Blindness coming on 11 years after operation may be fairly attributed to chronic glaucoma. At present, 15 years after operation, she is suffering only from the headaches caused by change of position and attributable to the large cranial defect.

CASE 2. R. H., a man 48, was admitted to the National Hospital in 1899 under the care of Dr. Beevor. A note was made by Dr. James Collier that for 3 years the patient had observed a gradually in-

Fig. 9.

Fig. 10.

Fig. 9 (at left). Case 5. C. H. before operation.
Fig. 10. Case 5. C. H. twelve years after operation.

creasing swelling on the left side of his head. For 5 months before admission he had had generalized headaches and for 3 months gradually increasing dimness of vision, and he had been told he had optic neuritis. During the last 2 months he had had four attacks of "giddiness" followed by transient weakness on the right side and difficulty in speech.

There was a hard symmetrical tumor, which appeared to be part of the skull, situated in the anterior part of the left parietal region.

Operation. Mr. Victor Horsley removed the bony tumor.

The specimen was preserved by Dr. J. S. Risien Russell, then pathologist, and a note made by him that "at operation the growth was found to have penetrated the dura. The subdural growth was not removed. The symptoms completely disappeared and the patient was apparently quite well 8 months after operation." The specimen was labeled in the museum catalogue "endothelioma of the skull."

Repeated efforts to trace this patient have met with no success.

Pathology. The bone was removed from the mounting fluid, decalcified and cut. It is porous and made up of trabeculæ of dense bone which interlace without definite pattern, like the partitions of a sponge. The arrangement resembles closely that seen in a number of cases reported below. The canals and cavities are filled with what appears to be connective tissue. But in other parts the tissue is much more cellular. It is not possible, however, to say with certainty from the microscopic picture whether or not the cells resemble endothelioma. This is probably due to the fact that the specimen had been 23 years in preservative. The architecture of the bone is the same as that seen in the proven cases however, and the specimen was labeled endothelioma (presumably after microscopic examination); there was a subdural growth associated with it, and the clinical history resembles that of the other cases reported. It seems, therefore, fair to assume that the bone was infiltrated with endothelioma and to include it here.

Fig. 11. Case 6. Roentgenograph of frontal bone. Spicules of bone have formed in the tumor.

Summary. A man, age 48, had noticed a gradually increasing swelling in the left temporal region, with headaches, increasing dimness of vision, and attacks of transient right hemiplegia associated with aphasia. The bone only was removed leaving the subdural tumor, and the patient was well 8 months after operation. There is little doubt that it was an endothelioma, although detailed histological description cannot be given.

CASE 3. J. T., a man of 32, was admitted to the National Hospital in 1899 under the care of Dr. Bastian. The patient had noted a swelling in the right frontal region for 10 years. During the same period of time he had had "fits," and latterly had developed left hemiplegia and some difficulty in speech. The swelling had become somewhat tender.

The following note was made by Dr. James Collier: "On the vertex of the cranium is an elevated area about the size of a five-shilling piece; firm but not tender on pressure. This is situated more on the right side than on the left of the middle line and just behind the situation of the anterior fontanelle."

Fig. 12.

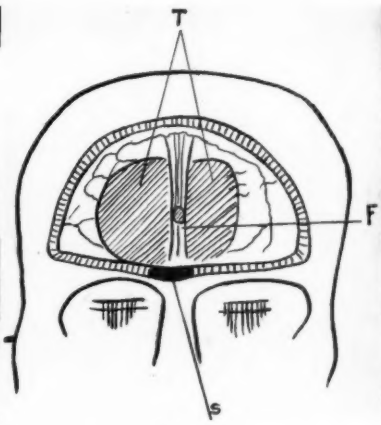

Fig. 13.

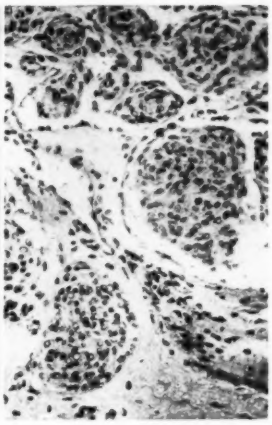

Fig. 14.

Fig. 12. Case 6. Frontal bone bisected through the tumor area.

Fig. 13. Case 6. Sketch which was found on operative note by Sir Victor Horsley and which shows the following findings: t, tumor as exposed in second stage of operation, attached to f, falx; s, frontal sinus.

Fig. 14. Case 6. Section from intracranial portion of tumor.

Operation by Mr. Victor Horsley. Stage 1: January 19, 1899. Scalp flap turned down exposing tumor in bone. Two trephine holes made. Stage 2: February 1. Removal of large piece of bone infiltrated with tumor. "Exposed growth in midline lying on dura . . . size of half a tangerine." This was removed, leaving the dura and neoplasm beneath it. Stage 3: February 6. Removal of a large tumor which penetrated down to the right of the longitudinal sinus and was adherent to the right frontal lobe. No further notes were made, but the patient died 12 days after the last stage.

Pathology. The following report was found in the postmortem register: "Large tumour involving and growing from the dura mater extending 4 centimeters into the left cerebral hemisphere, on the right about 3 centimeters. The growth is firm and hard and not very vascular, circumscribed, and does not infiltrate the brain substance. It is 13 centimeters in longitudinal direction, 8 centimeters transverse, 4 centimeters greatest depth."

The report of microscopical examination made by Dr. Batten is as follows: The tumor consisted of spindle cells with large nuclei and irregular and indefinite alveolar arrangement—variously designated "cylindroma," "endothelioma." A slice of the brain was found preserved in the museum, a photograph of which was obtained (Fig. 7).

Summary. A bony tumor situated on the vertex of the skull and extending more toward the right than the left had been present for 10 years, associated during that time with increasing neurological evidence of intracranial tumor. The tumor, which microscopically was reported as an endothelioma, resembled this type of tumor by appearing to arise from the dura of the falx and by invading both cerebral hemispheres without infiltrating nervous tissue. No sections were made of the *bony* tumor, but it was reported by the operator to be infiltrated by the underlying growth.

CASE 4. E. D., a woman, age 36, was admitted to the National Hospital under the care of Sir William Gowers, in 1908. Two years previously the patient had noticed, when combing her hair, a small, hard lump on her head. For over 7 years the patient had had frequent neuralgic pain in the head, not localized nor bearing any definite relation to the tumor. She sought medical advice only because, being a certified nurse, she was anxious to discover the nature of the lump. The following is from a note by Dr. Foster Kennedy: The tumor is the "size of a large plum and encroaches on the posterior aspect of the right parietal bone. It is hard and inelastic except at the anterior and outer corners where it is resilient and painful on pressure. The skin is freely movable over it."

Operation by Sir Victor Horsley. A scalp flap was made, the periosteum stripped and a trephine opening made in the skull behind the tumor. With saw and chisel a groove was made around it and the bony plaque lifted out. Below this lay a large mass of tumor infiltrating the dura. This was removed with the involved dura. Parts of two large veins on the underlying brain were removed and the ends ligated.

The patient bore the operation badly. Two days later hemiplegia developed, complete in the left arm and partial in the left leg. This became rapidly better, however, and on discharge the patient had a slight limp. Repeated efforts to trace the patient recently have been without avail.

Pathological report. The piece of bone removed was roughly oval in shape. On the external surface

Fig. 15.

Fig. 16.

Fig. 15 (at left). Case 7. J. B. before operation.
Fig. 16. Case 7. J. B. before operation.

was a well-marked lump the diameter of which was about 5 centimeters. The edges of the lump merged gradually into surrounding bone. "The pericranium was not apparently involved in the growth. The inner surface of the bone presented a very curious, pitted and worm-eaten appearance . . . In the center of the piece of dura removed, was a flattish, granular plaque of new-growth lying chiefly on the cerebral side of the membrane. On the cranial side of the dura, the membrane was moderately thickly studded with small granular deposits of growth."

Microscopic examination of the dura (Fig. 8) shows a layer of tumor lying on that membrane. The tumor is quite cellular, the nuclei for the most part ovoid, often arranged in whorls. The general microscopic appearance is quite typical of what is generally called a dural endothelioma. There are frequent layers of spindle-shaped cells. Connective-tissue septa may be seen passing through the growth, which are continuous with the tissue of the dura itself. The vessels are included in these septa. The dura is penetrated by strands of neoplasm but is not diffusely infiltrated. Some of the tumor cells are to be found in the vascular layer on the other side of the dura.

Summary. A woman of 36 had noticed a gradually increasing cranial boss for 2 years. There were no symptoms referable to the lump. For 7 years she had complained of generalized neuralgic headaches. The bony tumor was removed, and likewise a large, underlying endothelioma, infiltrating the dura but not brain. She left the hospital with a limp remaining from postoperative hemiplegia, but has not been heard of since.

Case 5. C. H., a man of 24, was admitted to the National Hospital under the care of Sir William Gowers. For 10 years before admission he had complained of attacks of pain in the right eye which had become more severe recently. For 2½ years he had observed a swelling of the right temple which increased in size, and which he thought to be a boil at first. It was tender to pressure for about 6 months and then was noted to be bony and no longer tender. For 1 year there had been right proptosis; for 2 months transient diplopia.

A note by Dr. Foster Kennedy describes the swelling as "apparently a bony tumour" (Fig. 9). Over it "the skin is tightly stretched with dilated veins. It is regular in outline, rises one-half inch from the general plane of the skull, and extends from the right external augular process to within one-half inch of the pinna. It is not discolored and only slightly tender to touch." The right eye was displaced downward, forward, and outward and there was 5 dioptres swelling of the right optic disc. The physical examination showed the patient to be otherwise normal.

Operation by Sir Victor Horsley. Stage 1: A scalp flap was turned down and the tumor with about one-half inch margin of bone was removed with trephine, saw, and rongeur forceps. "Two bosses of growth (bony) were growing from above into the orbit and were removed together with the orbital plate of the frontal bone. This involved the removal of the upper and outer portion of the orbital foramen. The eye was retracted upward and the malar bone with a portion of the superior maxilla, which appeared infiltrated with tumor, was removed. The dura was seen to be involved, "being covered with plaques of growth." These were cauterized with pure carbolic acid and the scalp flap closed. Stage 2: Five days later the wound was reopened, the cranial defect enlarged, the area dissected off, and a "protruding mass" shelled out with the finger. After some leakage of cerebrospinal fluid, the wound healed well and the patient made a "good recovery."

After operation. In May, 1921, 12 years later, the former patient was found to be actively engaged in his occupation, that of bank accountant, in London. He had returned to this work after 3 months' holiday. He complained of no headaches, no muscular weakness, no syncope, and his mental energy seemed in no way impaired. He walks 20 to 30 miles for recreation, rides a motor cycle, and has no complaints whatever.

In the right temporal fossa, there is a depression (see Fig. 10) surrounded by a smooth rim of bone. The gap is 8 centimeters anteroposteriorly and 7 centimeters up and down. A large part of the roof of the orbit is missing, leaving a gap of 5 centimeters in the orbital margin. There is no strabismus nor exophthalmos. On looking to the right, there is a very fine counter-clockwise nystagmus. On looking to the left, there is a very fine, lateral nystagmus with quick phase to the left. On convergence, the left eye tires at about 6 inches and deviates outward. Only a few fibers of the right temporal muscle contract. There is weakness of the facial muscles on the right. Apparently, he was otherwise normal.

Pathology. The bony tumor, including the outer margin of the orbit and covered on one side with temporal muscle, weighed 140 grams. Its thickness from within out was 1 inch. From the second stage of the operation, the specimen was a large oval tumor of the consistency of brain, 3¾ inches by 2¾ inches

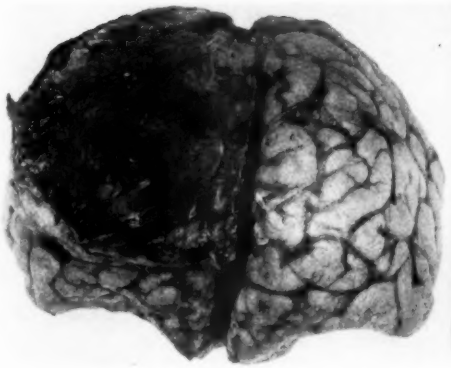

Fig. 17.

Fig. 17. Case 7. Neoplasm spread over left frontal pole. Dura has been removed except where it is attached to tumor.

Fig. 18.

Fig. 18. Case 7. The bony tumor, quite cellular at apex, has been sawed in half. White dura adherent to under surface.

by 1½ inches and weighing 107 grams. "The whole was covered by pia mater" and dura was attached to the mass at one end.

Microscopically, the tumor was reported to be a "typical endothelioma." The sections, which were preserved, show the canals of the bony tumor to contain one or more blood vessels each, together with cells whose nuclei vary from oval to spindle shape and which appear to be identical with the cells of the intracranial endothelioma. The temporal muscle is likewise invaded by these cells.

Summary. Young man complained of pain in right eye 10 years, of a hard tumor in the right temporal fossa 2½ years, right exophthalmos 1 year, and right papillœdema. By operation in two stages, a bony tumor filling the temporal fossa and entering the orbit was removed, and a large encapsulated intracranial tumor shelled out. Both were adherent to the dura. Microscopically, the tumor corresponds to the type usually called dural endothelioma. Temporal muscle, bone, and dura were infiltrated with growth, but not brain, although the tumor had displaced a considerable amount of brain. Much bone had been laid down in the extradural growth of the tumor. Twelve years after operation, the patient has no complaints and shows no evidence of recurrence.

Case 6. H. M., a boy of 18, journalist by occupation, was admitted to the National Hospital in 1910, under the care of Dr. Risien Russell. For 1 year he had complained of headaches just above the eyes. Recently he had noticed "mistiness" in both eyes. For 1 month there had been severe vomiting. He believed his forehead had changed in shape.

There was a smooth, rounded, mesial prominence on the patient's forehead, with a diameter of 2 inches, not tender. The lateral roentgenogram shows the outer table of the frontal bone and superimposed on this, lines of increased density radiating outward at right angles to the surface of the skull, suggesting spicules of bone (Fig. 11). He was described as "intelligent, memory and attention good, no decrease of mental powers." Vision was reduced to 6/36 in both eyes, bilateral papillœdema. Examination showed him to be otherwise normal.

Operation by Sir Victor Horsley. An incision was made from one temporal fossa to the other. The scalp flap thus made was turned down over the face. The scalp was adherent to the growth. After a trephine opening was made, the tumor was encircled with saw cuts (hand-saw), leaving about 1 inch of normal bone about the tumor. The frontal bone was thus removed *en bloc* down to the orbital ridges (Fig. 12). The dura was described as white and opaque over the right frontal lobe, but no mention was made of whether or not it was adherent to the bony tumor. A plug was left in the left frontal sinus and the scalp flap closed.

Seven days later the wound was opened. The dura over both frontal lobes was incised and reflected to the midline. Projecting into the brain "but with a fairly clear margin, a tumor was seen . . . It extended 2 inches to the right and 1½ inches to the left (Fig. 13). It appeared to be attached to the falx." After ligation above and below, that part of the falx was removed along with the tumor which was soft and colored a bright yellow in parts. It appeared to extend through the frontal lobes to the floor of the anterior fossa. A "plug" was left in the frontal sinus and another in the cavity caused by the removal of the tumor.

After the operation, the patient made an excellent immediate recovery. The wound however began to discharge pus. He became mentally irresponsible, imagining impossible things. He was likewise obstinate and lost his initiative, although his memory seemed unimpaired when he was carefully examined. He died 7 weeks after second stage of operation.

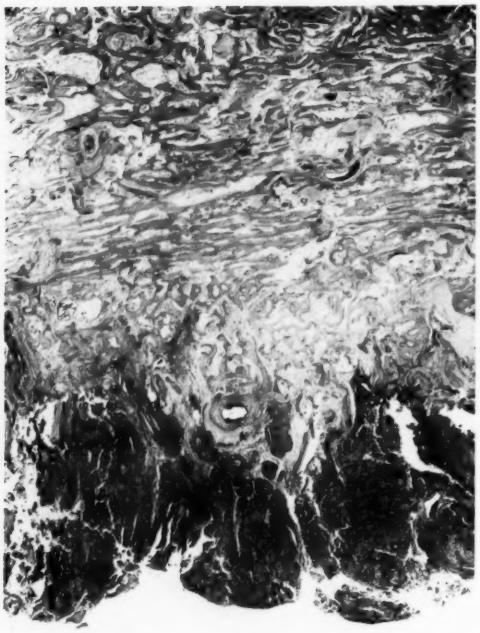

Fig. 19. Case 7. Endothelioma cells may be seen in the canals of the bone. The layer of cellular tumor is on the internal surface of the bone.

Pathology. The frontal bone "is evidently infiltrated by growth" . . . "The intracranial aspect is smooth," the inner table appearing normal. "The outer table is, to a certain extent, lost in the growth (Fig. 12), but its general outline can be followed, and projecting outward at right angles to the outer table are spicules of bone closely set, and among them apparently new-growth. The outer surface of the bone is smooth."

The intracranial tumor weighed 100 grams. It "was not encapsulated and had evidently infiltrated the brain tissue. Part of the growth was of a yellow color and was extracerebral, and seemed to be covered by a thin membrane." The tumor was adherent to dura, and a nodule of growth had penetrated this membrane.

Portions of the bone were decalcified for microscopical study, as well as blocks of the soft tumor, and the pathologist's report is "typical endothelioma which had infiltrated the bone and frontal lobes." Sections of the bone could not be found for re-examination, but sections of the soft tumor show cellular areas (Fig. 14), where the nuclei vary from round to spindle shape and blood vessels are numerous. Other areas are myxomatous, especially at the periphery, where in one section there is a definite lining membrane. This suggests that the intracranial tumor may have been wholly encapsulated.

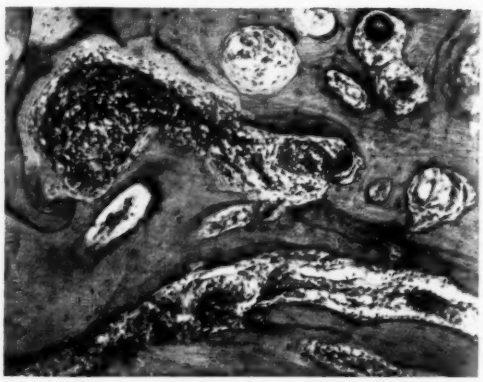

Fig. 20. Case 7. Photograph of section from central bony portion of tumor.

Because of its soft consistency, however, it would have been difficult to remove the growth intact in its capsule.

Summary. A boy of 18 complained of pain above the eyes for 1 year, and vomiting for 1 month before admission. He had failing vision and bilateral and choked disc. A hard symmetrical prominence on his forehead was found to be endothelioma, in which radiating spicules of bone had been laid down, as shown by roentgenogram and pathological examination. The scalp was adherent. One cannot be certain whether or not it had been invaded. The dura bore some endothelioma on its outer surface and was adherent to a large intracranial growth of the same nature, which invaded both frontal lobes and seemed to arise from the falx. This tumor was partly encapsulated. Whether or not it actually infiltrated brain substance seems doubtful. Death from sepsis may perhaps be attributed to the fact that it was necessary to open the frontal sinuses.

Case 7. J. B., a man of 47, was admitted to the National Hospital under the care of Dr. Risien Russell, in 1911. Seventeen years before admission he had had a heavy blow on the head with a bar of iron. For 10 years he had noticed a swelling of the left frontal region which gradually increased in size. During the past year he had complained of frontal headaches. During this time he had become slack in his work and found difficulty in writing. Shortly before admission he became dull, unsteady in gait, and was reported to have acted strangely.

He presented a "large, almost hornlike prominence on the forehead to the left of the midline, which shelves backward and to the right for about 2½ inches. The swelling is hard and not tender to any marked degree." His speech was slow, hesitant and explosive. He had "optic neuritis," but whether in one or both eyes is not mentioned. No other abnormal physical signs were noted (Figs. 15 and 16).

Operation by Sir Victor Horsley. The scalp was adherent to the tumor and there was much oozing of

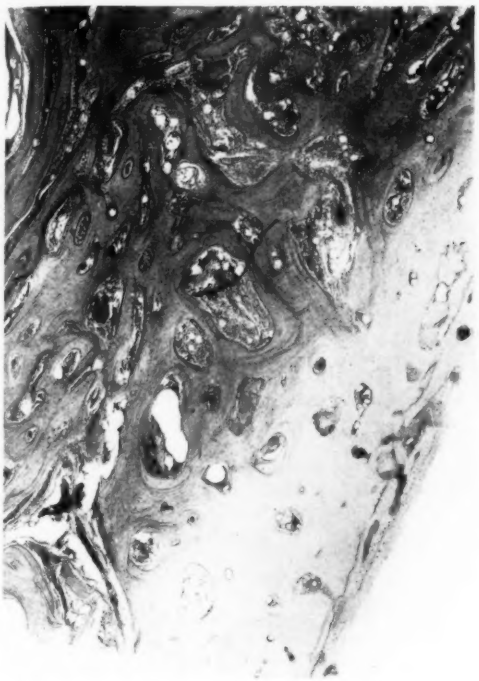

Fig. 21. Case 7. On the right the skull is beginning to appear normal.

Fig. 22. Case 7. Photograph of external portion of tumor where there is more endothelioma and less bone.

blood after the flap had been turned down. The bony prominence was encircled by double saw cuts, made with a hand saw, and was then broken free, together with a surrounding margin of one-half inch normal bone. The dura was densely adherent to the under surface of the bone thus removed. This adherent area, as it was presented on the exposed dura, was 2 inches by 1½ inches and appeared as a "dark red fungating mass. There was a good deal of oozing of blood from it also." This area was burned with pure carbolic acid and the wound closed.

Death followed a few hours later.

Postmortem examination showed a "sessile, fungoid mass passing through the dura at the left frontal pole (Fig. 17), of a dark reddish color and about 2¼ inches in diameter." After the brain was hardened, the dura was removed. The mass, which was bounded on one side by the superior longitudinal sinus, came away with the dura leaving the frontal pole excavated but free from growth. Transverse sections showed the structures of the left hemisphere to have been displaced backward.

Microscopic sections of this case had been preserved. The intracranial tumor removed at autopsy is moderately cellular and is endothelioma in type. There are many spindle and oat shaped nuclei whose nuclear ground substance stains more darkly than that of the oval nuclei. The tumor is only moderately vascular, there are numerous whorls and the palisade arrangement of cells is frequent.

The bony tumor was found among the pathological specimens. In bi-section dense bone may be seen at the base, 4 centimeters in thickness. On top of this is heaped tumor and bone about 2 centimeters in thickness. Dura and a small nodule of tumor were found adherent to the under surface of the bone. Under the apex of the growth is an area where the bone is less dense. This extends through to the inner surface.

The splendid sections of decalcified bone, prepared while Dr. Hinds Howell was pathologist, show that on the inner surface (Fig. 19) is a layer of tumor whose cells resemble those of the intracranial growth described above. Next to this the bone is infiltrated with these cells. The haversian canals are filled with endothelioma (Fig. 20). Passing laterally to the area where the thickness of bone approaches that of the normal skull (Fig. 21), the canals filled with growth disappear. In the external part of the tumor, the summit of which was reported as adherent to the scalp, the amount of neoplasm in proportion to the amount of bone is greatly increased. Here spicules and irregular islands of bone are scattered throughout the growth (Fig. 22). For a higher magnification of this same area, see Figure 23, where an island of bone has been laid down in the substance of the tumor.

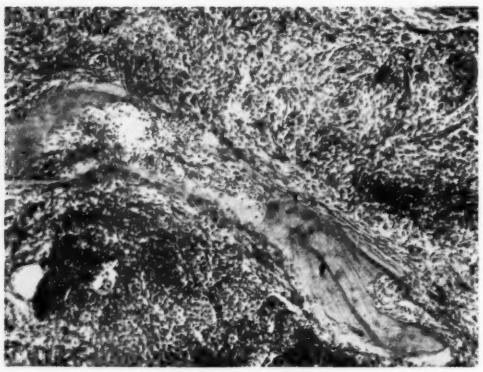

Fig. 23. Case 7. Same area as that seen in Figure 22. An island of newly forming bone.

It may be seen that this island of bone is not directly in contact with the typical cells of the endothelioma, but that there are on the surface of the bone, cells with elongated nuclei presenting a different appearance. A higher power drawing was made of the surface of such a bit of newly formed bone (Fig. 24). It is apparent that the bone is being laid down under this layer of cells, which resemble connective-tissue cells and which are apparently continuous with the connective-tissue septa that extend outward into the substance of the endothelioma. To judge from these sections, bone is being laid down in the tumor itself by the same type of cell that we call osteoblasts, as seen in repair of bone.

Summary. A man of 47, with a history of 10 years' growth of a hard, insensitive tumor on the left forehead, complained of frontal headache for 1 year. There were mental changes and difficulty in writing. At operation a large, flat, fungating, red tumor was exposed, attached to the dura and displacing but not infiltrating the brain. This was continuous through the dura with the growth on the exterior, which had infiltrated the skull and in turn become partially ossified. At the summit of the cranial boss was a plaque of tumor cells, containing only an occasional island of bone and apparently infiltrating the scalp. The patient died from the immediate effects of operation.

Microscopically, the tumor was a so-called dural endothelioma, and it filled the canals left in the newly-formed bone. Between bone and tumor may be seen connective tissue or bone cells.

Case 8. E. H., a man, was admitted to the National Hospital under the care of Dr. Batten. For 1 year he had noticed a lump in the left temporal fossa and during that time had complained of headaches, at first localized near the lump, and later becoming generalized. He had experienced diplopia for 2 months and reported one attack of numbness of the right face which was associated with weakness of the left arm and leg which passed off in a week's time.

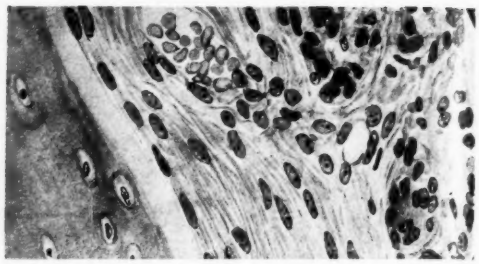

Fig. 24. Case 7. Drawing showing the surface of a newly formed island of bone at left, cells of the endothelioma at right, and between the two a layer resembling connective tissue.

The patient presented, as described by Dr. F. M. R. Walshe, double proptosis which was more marked on the left side. There was "optic neuritis" and lower facial weakness on the right. "The left temporal fossa is completely filled out and is seen as a round bulging prominence. The skin over this is normal in appearance and mobility, and the surface of the swelling is regular and smooth. On palpation, the mass is hard and does not fluctuate. On pressure there is slight tenderness." This tenderness seemed to be in the muscle itself. The intelligence was reported as mediocre. The Wassermann reactions in blood and cerebrospinal fluid were negative. Lumbar puncture gave rise to immediate vomiting and collapse.

Operation by Mr. Percy Sargent. A scalp flap was turned down. The temporal muscle was found to be invaded by "pale lobulated growth." The bone of the temporal fossa was thinned in parts, vascular, and bled freely. A large piece of infiltrated bone was removed. The surface of the dura bled so freely that it was packed and the wound closed without the dura having been opened. Death followed in 36 hours.

Some "pieces of skull with growth attached" are recorded as having been received in the pathology laboratory. The specimens were found preserved in formalin. Microscopical sections show that the bone is porous. The spaces are filled with typical endothelioma. In the tumor masses, the cells are frequently arranged in whorls. Their nuclei vary from a large, round shape to elongated forms. At the periphery, small islands of what appears to be new-formed bone may be seen. These islands are separated from the tumor cells by an intimate covering of cells resembling connective tissue and apparently identical with the connective-tissue framework of the neoplasm.

The report of the postmortem examination is as follows: "In the anterior part of the wound, the skull is evidently infiltrated with growth and the upper wall of the orbit is similarly infiltrated. A large, soft, flattened mass of tumour lies over the frontal area of the left hemisphere."

Summary. The patient had observed a lump in the left temporal fossa for a year and complained of

headache focused on this area. There had been diplopia and an attack of transient hemiplegia. At operation the muscle and bone of the temporal fossa were found to be infiltrated with endothelioma. Death followed operation and further examination showed a layer of tumor lying over the hemisphere beneath the dura. The bone which is porous is separated from the infiltrating neoplasm by connective tissue.

CASE 9. W. W., a man of 45, was admitted to the National Hospital under the care of Dr. Hinds Howell in October, 1920. For 2½ years he had noticed a lump on the left side, following a fall from his bicycle; but he believed there had been a "bit of a lump" there since childhood. He had become dizzy and fallen from his bicycle several times in the past 2½ years. For 9 months he had had numbness in the right leg and hand. For 6 months before admission he had been troubled in his occupation as postman by difficulty in writing and spelling. Memory for recent events became defective. For 4 months there had been frontal headache.

Over the left posterior parietal region there was a tender œdematous prominence rising from 2 to 3 centimeters above the normal cranial outline. There was weakness, some inco-ordination and inability to detect minor differences in sensory stimuli with the right hand. There was also loss of sense of position in the right thumb and great toe. Deep reflexes were increased on the right. Plantar responses were flexor. He was mentally confused.

Operation by Mr. Sargent. First stage: A scalp flap was formed so as to expose the prominence in the left parietal region. There was what appeared to be a neoplasm about one-fourth inch in thickness between the scalp and periosteum. The skull and scalp appeared to be infiltrated. A piece of tissue was removed for histological examination and the wound closed. Second stage: Six weeks later the scalp was turned down again. It was adherent to the bone over an area 6 to 8 centimeters in diameter, both structures being infiltrated with neoplasm which was very vascular. A trephine opening was made and the involved area of bone encircled with rongeur forceps and hand saw. The bone within the circle was removed, exposing part of the longitudinal sinus. The underlying dura was adherent to a tumor beneath it which was invading the postcentral gyrus about 1 centimeter from the longitudinal fissure. This tumor was about 2 centimeters in diameter, was translucent and gelatinous. No definite limiting membrane could be made out. Most of the growth was removed. An unsuccessful attempt was made to dissect neoplastic tissue free from scalp.

After operation the patient made a good recovery except for a few days when he had hallucinations. On discharge he seemed mentally normal and the loss of sensory discrimination had practically cleared up. A letter written by him in a good hand 5 months after the operation stated that he was working for the post office, and that "I have had *no* bad headaches, eyesight good, have full use of my limbs, memory normal, and no difficulty in speaking. I might also mention that there is no disfigurement left by the operation and that my duty necessitates a 20 mile tramp over hilly country every day, Sunday included, and I am never knocked up by it." A second letter 14 months after operation reports that he is still perfectly well.

Pathology. The tissue removed during the first stage of the operation was reported by Dr. Greenfield as dural endothelioma. Sections of the bone show that it is made up of trabeculæ interlaced so as to form a bony sponge. The cavities and canals are filled with tissue, which, although poorly preserved, resembles endothelioma inasmuch as there are frequent whorls about vessels and the nuclei are close together. In the center of the bone most of the canals run parallel to the surface while nearer to the surface there is no definite pattern.

Summary. A man 45 years of age had noticed a lump on the left parietal bone for 2½ years. For 9 months there had been numbness in right hand and leg, and for 6 months difficulty with memory for recent events and with writing and spelling. He was mentally confused and had lost the power of sensory discrimination in both extremities of the right side. Operation revealed an endothelioma invading skull and scalp and, attached to the under surface of the dura, it had invaded cerebral cortex as well. Recovery was rapid and he has no abnormal symptoms 14 months after operation. Examination of the specimen removed at operation shows the bone to be porous and infiltrated with tissue resembling endothelioma, while the underlying tumor is a typical dural endothelioma.

CASE 10.[1] W. E., a man of 60, was admitted to the National Hospital in 1894 under the care of Sir William Gowers. He was comatose on admission. His wife stated that he had had a lump on his skull for 10 years, that he had become strange mentally and developed a left hemiplegia 6 weeks before admission. He died in the hospital and at postmortem examination, there was described a "bossy projection" on the vertex of the skull just to the left of the midline. "On removing the skull cap, the prominence was found to correspond to a tumor which was situated in the dura mater and projected upward and also pressed on the ascending parietal convolution causing a depression." There was also a tumor in the centrum ovale of the right hemisphere. The report does not make it clear whether or not this tumor was co-extensive with that attached to the dura. The following note is added: "A small scraping of the tumour shewed it to consist mainly of small, round cells with a few branched cells like those of a myxoma." It is not clear from which tumor these scrapings were obtained.

Summary. A man of 60 admitted in coma with a history of 10 years' growth of a hard swelling over the vertex of the skull. For 6 weeks he had been

[1] This case is the only one in the series without a satisfactory histological examination, but as there was a hard prominence of the skull under which lay a dural neoplasm, it is included in the series.

hemiplegic. At autopsy, a neoplasm of the dura was found beneath the prominence and another, possibly separate, tumor in the centrum ovale of the other side.

REVIEW OF LITERATURE[1]

In 1883, Drummond (8) cited a case of tumor of the skull, reported by Louis, which was of 9 years' duration and which Louis considered to be a special form of tumor of the dura.

Brissaud and Lereboullet (4) in 1903 described, under the title of hemicraniosis, two cases presenting a bony prominence of one side of the skull. In only one was there a microscopical examination. This was a woman of 31 who had a large hard prominence over the right frontal bone. For 2½ years she had complained of headache, vomiting, and intermittent strabismus. She showed marked exophthalmos and bilateral papillœdema. She died in hospital and at autopsy the right frontal bone was found very much thickened, including the supra-orbital ridge. The under surface of this thickened bone was adherent to dura, which in turn was studded on *its* under surface with small and large circumscribed tumors which displaced the frontal lobe. The bases of the tumors where they were sewed over the dura, were calcified and gave the appearance, according to the authors, of angiolithic sarcoma. The bone was not decalcified and examined.

The cranial enlargement was one-sided in this case, and likewise in the other case in which no pathological examination had been made. The authors, therefore, considered the condition to be the converse of facial hemiatrophy, except that the hypertrophy seemed to be limited to the ophthalmic division of the fifth cranial nerve. They call attention to the curious rôle the dura seems to play: that of developing exostoses on one side and multiple tumors on the other. The picture of the patient shows a large, smooth prominence on the frontal bone which only differs from the picture of J. B. (Fig. 15), in that the prominence is a little more one-sided. The tumors growing from the dura without infiltrating brain may be fairly considered to belong to the type called by many psammoma or endothelioma.

In 1904 Parhon and Goldstein (14) reported a second case of hemicraniosis with histological examination. A woman who had died of pneumonia was found to have a lump on one parietal bone. The underlying dura was adherent to the bone and attached to a large circumscribed tumor which had displaced brain. The bone was said to be eburnated and the underlying tumor an angiolithic sarcoma or psammoma.

In 1905 Parhon and Nadjede (15) reported another case, a woman of 63 who at autopsy showed a smooth excrescence on the right frontal bone. The under surface of the bone was irregular and beneath it, attached to the dura, was a large, red-grey, angiolithic sarcoma or psammoma which did not infiltrate brain tissue. It was noted that in this and the preceding case, although there was no supra-orbital thickening, the process was otherwise the same as that described by Brissaud and Lereboullet.

In 1907 Spiller (17) reviewed the other three cases of hemicraniosis described above and added two more, brief descriptions of which follow.

CASE 1. The patient received a blow on the head 16 years before admission. He had noticed the beginning of enlargement of the left parietal region 8 years before, for 3 years paræsthesia in the right side, and for a few months convulsions, nausea, and vomiting. The patient died from hæmorrhage following attempted operative removal of the bony tumor which was adherent to the dura. The pathological examination by Dr. Kirkbride showed that the tissues of the scalp which had lain over the tumor were much indurated, there being marked increase in the fibrous tissue between the bundles of which were occasional, small spicules of bone. On the outer surface were nodular exostoses and shreds of adherent pericranium. The inner surface of the bone was convex and honeycombed, with dura adherent to it. Beneath the thickened skull, a large gray encapsulated tumor was found attached to dura and falx.

The tumor was an endothelioma and, from the careful microscopic description, it is apparent that the skull and probably the scalp were infiltrated with neoplasm as well.

CASE 2. The patient complained of right-sided paresis and some aphasia. A hard swelling had been noticed for 6 or 7 months in the left parietal region of the skull. At operation, Frazier removed the tumor of the skull. It was examined microscopically and reported to be free from tumor cells. At the second stage of the operation, the same operator shelled out from beneath the exposed dura an endothelioma.

It would seem that both of these cases resemble the series of cases reported in this paper. In the first case the bone and probably the scalp were infiltrated with growth, to judge from the microscopic examination. The negative report of the microscopic examination of the bone in the second case comes as a surprise in the face of the fact that the bony prominence had been noted only 7 months before admission and was, therefore, probably increasing in size.

One more case was quoted by Spiller. In 1906, Barling and Leith (3) reported the case of a man of 30 who for a year had had attacks of Jacksonian epilepsy together with right-sided paresis and headaches. A trephine button of bone was removed by another operator and the operation was abandoned because of hæmorrhage. Six months later the patient was operated upon by Mr. Barling. The wound

[1] This paper as published was entered in the competition for the Warren Triennial Prize at the Massachusetts General Hospital in April, 1922. This explains the fact that no reference is made to an article published by Dr. Harvey Cushing in the August number of *Archives of Neurology and Psychiatry* entitled "The Cranial Hyperostoses Produced by Meningeal Endotheliomata." In this article the type of neoplasm under consideration is described and a splendid example given. Cushing states that 25 per cent of the endotheliomata in his series are associated with overlying "hyperostosis cranii" although he does not state in this preliminary communication in how many of this group the bone was studied microscopically. His view is much the same as that set forth in this paper; that the process is one of "invasion of the bony canals by tumor cells, with resultant stimulation of osteoblasts and the production of new bone."

showed no implantation of tumor in it, nor any fungating mass. The bone which was adherent to dura was removed, and at a second stage an underlying endothelioma was lifted out. Professor Leith, in a very careful report, stated that the bone over the growth was slightly thickened, more spongy and more vascular than normal. Tumor cells penetrated the diploe, a few reaching the outer table. The "increased porosity," he stated, was apparently brought about by small irregular cells lining the spaces. No large osteoclasts were seen. He argued for extension into the bone by continuity through numerous small openings in the dura. In this case no lump was noted before operation, and this may be taken, perhaps, as a very early stage in the bone invasion before much new bone had been laid down.

To the six cases collected by Spiller, which include two of his own, may be added five others.

In 1904, Bruns (5) cited a case, reported by Roemer, of endothelioma a part of which lay between skin and skull and part in the diploe. The tumor projected into one frontal lobe.

Ballance (2), in 1907, described a patient who presented a hard smooth swelling in the right frontal region, which had been noted first 7 years previously. He had been subject to epileptic seizures dating from the same time and headaches for 18 months. Operative removal of the bony prominence was followed quickly by death. At postmortem, a cerebral tumor was found beneath the cranial defect. After examination, it was suggested that this tumor had commenced as a "hæmangio-endothelioma and developed into a more common form of sarcoma." The overlying bone was 1¼ inches thick at its center and presented a "coral-like appearance due to infiltration with new-growth."

Krause (10) describes in his *Surgery of the Brain*, 1912, an operation performed by him in 1904 on a man of 41 years, who had noticed a lump on his right forehead for 5 years. During that time he had had severe headaches and for 2 years epileptic convulsions. For a short time he had shown mental symptoms. The tumor of the skull, which was about the size of a goose egg, was removed and, because of hæmorrhage, operation was discontinued. Death from pneumonia followed. When the dura was lifted from the brain at postmortem examination, an encapsulated, bluish tumor the size of a billiard ball was lifted out by its attachment to the dura. This intracranial tumor had penetrated the outer layer of dura beneath the bony prominence, but, unfortunately, there is no microscopical report of either tumor. Krause observed that this was a rare instance of an encapsulated brain tumor, giving evidence of its presence externally.

In 1917, Tattersall (18) reported the case of a patient, who died in an Insane Asylum, with a hard swelling in the right temporal fossa. There had been 10 years of headache and vomiting. Mentally the patient was childish and memory was defective. The bone was reported as resembling a flattened, fusiform, osseous plaque consisting of cancellous growth of bone from both surfaces. It was not adherent to the dura but externally the scalp was infiltrated. Beneath the dura and adherent to it was an "extremely necrotic growth" occupying the whole width of the hemisphere. Microscopically, it was an endothelioma. Sections of the bone showed that *it* contained the same neoplasm.

Ashurst (1), in 1920, reported the case of a patient who had noticed a hard lump slowly growing in the right parietal region. For a year he had had occasional epileptic convulsions, and for 3 weeks headache and vomiting. The bony tumor was removed at operation and its under surface found to be eroded, the outer surface being adherent to the aponeurosis. A circumscribed intracranial tumor attached to the underlying dura was removed as well, and the patient made an excellent recovery. The tumor itself was examined microscopically by Spiller, who classed it as an endothelioma and was quoted as saying: "He was further of the opinion that such growths in the brain were frequently the result of irritation from a lesion of the skull originally traumatic in origin. This had been Dr. Ashurst's belief at the time of operation."

In a personal communication, Dr. Spiller adds another case from his wide clinical experience. He had a patient who came to him with enlargement of a limited portion of the skull and some intracranial symptoms. He made a diagnosis of endothelioma and advised operation, which was refused. Several years later the patient died, and an endothelioma was found where it had been suspected.

The cases collected above show striking similarity clinically and histologically. Of the 11 cases described only two gave a definite history of trauma, one of them 4 years before the onset of symptoms, and the other 8 years before that time. In 9 of the cases the patient had noticed a lump on the skull on an average of 4.3 years before admission. No history is recorded in the case of two patients. The first symptom was epileptoid seizures in four cases, headaches in three, and hemiplegia in two.

The tumor itself was declared to be an endothelioma or angiolithic sarcoma in all but one case, and in this case there was no microscopic report. It was adherent to the dura in every case in which there was a careful description. The bone was specifically described as infiltrated with neoplasm in four cases. In only three cases were microscopic sections of the bone reported. In two of these tumor cells were found to fill the bone canals. In the third, the bone was reported as free from growth. Seven of the reported cases were operated upon. Of these, four died as the immediate result of the operation and three survived and showed satisfactory improvement.

GENERAL DISCUSSION

In addition to the above cases collected from the literature, tumors of the type described in this paper must have been encoun-

tered by many brain surgeons and neurologists.[1] The nature of the osseous part of the tumor and the fact that one has to deal here with a well-defined group of cases has been overlooked. Bruns (5), describing the sarcomata which arise in the neighborhood of dura mater and grow both ways, perforating the skull, says that he has been of the opinion that these tumors are derived from dura and bone and are not sarcoma but endothelioma. An accompanying diagram, however, shows a tumor *perforating* the skull, not infiltrating it. Oppenheim (13), in a monograph on tumors of the brain, mentions sarcomata which may grow from skull, dura, or brain, and at times perforate the skull.

Sarcomata, perforating the skull, have been frequently described and seem to be more clearly recognized than endotheliomata which infiltrate, and cause bony lumps on, the skull. To judge from the reports of the 420 cases of brain tumor examined for this study, the latter group is very much more common. (The term sarcoma was used formerly by many authors to mean what is now called endothelioma.) The cases were, of course, in a certain sense selected inasmuch as they had all been referred to a hospital for diseases of the nervous system.

Foster Kennedy (9), referring to whorl-celled endotheliomata says, "not infrequently these neoplasms arising from the falx or other portion of the dura mater produce by irritation of the periosteum of the skull, such localized thickening of the bone as to give rise to bony knobs on the cranium, which invite by their appearance the diagnosis of primary osteomata of the skull." Krause (10) takes a somewhat similar view of these dural endotheliomata, observing that, since the dura performs the function of the inner periosteum, it is not surprising that, as a result of irritation, the bone is induced to grow and is found heaped up in such cases, as much as 21 millimeters over the growth.

Even though one supposes that the endothelioma is primary and the bony excrescence secondary to it, it is difficult to conceive why direct irritation of the dura or internal periosteum should cause an external tumor of bone. In many cases there is little or no elevation on the internal surface of the skull and frequently there is erosion of the under surface of the bone.

On the other hand, a different explanation has been offered by Parhon and Nadjede (15). They recall the fact that Babès, in discussing such a tumor with an overlying osseous prominence, suggested that the old bony lump had caused the intracranial tumor by irritation; but he stated that it was the first time he had seen a tumor of one nature give rise to another entirely different in character. The authors then suggested the theory that there is some irritative process in the dura, causing it to lay down tumor on one side and bone on the other. They profess ignorance of the pathogenic agent which causes such dural activity, and suggest experimental extradural injections of irritative fluid in an attempt to reproduce the condition.

Spiller's explanation, somewhat similar to that of Babès, is that the lesion of the skull in the nature of a "local thickening" appears first, probably, as the result of trauma. Secondarily, "pressure from the thickened bone . . . on the dura is liable to cause the formation of endothelioma growing from dura" (17).

In regard to the part played by trauma, it may be noted that in only 2 of the 10 cases reported in this paper was there record of any cranial injury, and in one of these cases the injury preceded the appearance of the tumor of the skull by 7 years. Nevertheless it cannot be denied that trauma may be a factor.

Operations on these cases offer a real hope of permanent cure. Of the 11 cases reported in medical literature, 6 of them had been operated upon. Two of the patients, who had cranial bosses of 7 and 8 years' duration respectively, died from operative hæmorrhage, and one from pneumonia several days after operation. The remaining 3 cases made a good recovery from operation and were discharged cured or improved. There is no record of what finally happened to them, except that one died during a plastic operation 6 months after the removal.

Of the 10 cases reported in this communication, 9 were operated upon either by Sir

[1] Cushing (7) refers to "hyperostoses which sometimes signal the presence of endotheliomata below."

Victor Horsley or Mr. Sargent. Two died within 36 hours after the operation. One died 12 days after, cause of death not stated, and the fourth died 7 weeks after operation as a result of sepsis. The other 5 were discharged quite cured, except that one patient had a limp from a hemiplegia which developed as a sequel to operation. Three of these patients are living today, 16 years, 12 years, and 14 months after operation, respectively. They have had no recurrence and are perfectly well, so far as their original malady is concerned, except that one suffers from headaches as a result of an unusually large cranial defect. No trace can be found of the remaining 2 cases which survived operation.

These neoplasms are invariably extremely vascular, and removal of the cranial portion without opening the dura may result in hæmorrhage, and perhaps operative shock, sufficient to cause death. After the scalp flap is turned down, it seems to be best to encircle the bony prominence by cuts through the normal skull. The bone can then be broken away, leaving the adherent dura behind. The operation may be stopped at this point, and the dura and underlying tumor removed at a second stage operation, or the whole procedure completed at once, depending on the patient's condition.

Operation should, of course, be as early as possible, inasmuch as this is a type of brain tumor which holds out promise of a brilliant result to the successful operator. To this end, it is of importance that the early signs and symptoms should be commonly recognized.

In this series of 10 cases, all of the patients had noticed an increasing lump on the cranial vault, before admission. In 4 cases it had been the first evidence of anything wrong, and in 2 cases the enlargement was not noticed until the onset of the first symptom. In 7 of the 10 cases, the first symptom complained of was pain, usually most intense beneath the cranial boss. In 2 cases the first symptom was an epileptoid seizure and in the remaining case, there is no mention of the early symptoms. There was a time, then, in 70 per cent (possibly 80 per cent) of the cases when the patient had only the typical bony swelling and pain beneath it, usually of a stabbing character. This is the time when the diagnosis should be made and the operation performed. In one instance the patient, a nurse, sought advice because of curiosity over a slowly growing cranial lump. Her only complaint was "neuralgic headaches," not localized. Thanks to their great experience, Gowers and Horsley recognized the nature of the condition thus early, and the tumor was successfully removed.

The symptoms which follow pain are due to encroachment on the cerebrum. Epileptoid seizures are common. There may be hemiplegia or symptoms of increased intracranial pressure, depending, of course, on the location and size of the tumor. The most frequent location is frontal, but the temporal or parietal bone is often the site of the neoplasm. Not infrequently, one or both orbits are involved and the falx is at times infiltrated. There is no record of such a tumor in the occipital or suboccipital regions.

There is a considerable variation in the age incidence. The youngest in the series was 18 and the oldest 60 years. The average age was 39. Of the 17 cases including 7 from the literature, five were women and twelve were men.

HISTOLOGY

Endothelioma of the dura is a term that one would like to drop altogether if it were not for the sanction of common usage. As a matter of fact there is no proof that these tumors develop from the endothelium of blood vessels and, although the term has been used in this paper, it is recognized that the name is *not* a good one.

Endotheliomata and psammomata are generally understood to be circumscribed tumors which grow very slowly, do not metastasize, and are benign in the sense that they are usually covered by a limiting membrane. Histologically, they present characteristic whorls and occasionally a "palisade" arrangement of cells. This type of tumor has been said to arise from the inner layer of the dura (Monckeberg, 12). It rarely penetrates the outer layers of the dura (Krause, 10, vol. i, p. 72), usually growing inward and pushing brain before it.

In 1903, Schmidt (16) proposed that the so-called sarcomata and psammomata of the

dura arise in reality, not from the dura mater, but from the arachnoid. He described the manner in which pacchionian granulations begin, i.e., as tufts of arachnoid capped with cones of solid cells, which penetrate the dura, usually following vessels, and pierce its outer layer. His reasons for urging the development of these tumors from the pacchionian granulations include the similarity of histological pictures, the tendency to similar location, and the continuity of structure demonstrated in several cases between tumor and pacchionian body.

Mallory (11, 1920), in a careful histological study of dural endotheliomata, reached a conclusion similar to that of Schmidt. He states that there is no dural endothelium and that the internal aspect of dura is bare except for fibroblasts. These tumors which he would call arachnoid fibroblastomata arise, he maintains, in the arachnoid and receive their blood vessels and connective tissue from the dura.

Cushing and Weed (6), in 1915, suggested the same derivation, and Weed (19), in an anatomical study, described cell clusters in the arachnoid membrane. The clusters increase with age and usually become adherent to the dura. In two cats he found small neoplasms on the arachnoid. The smaller of the two was slightly adherent to the dura but a line of cleavage remained. The larger one was intimately adherent, although not infiltrating the dura. He calls attention to the fact that these cell clusters present the same histological picture as endothelioma and frequently show typical calcareous granules or corpora amylacea.

The peculiarity of the series of endotheliomata reported here is not only that they have infiltrated the overlying skull and sometimes scalp, but that they have caused to be laid down more bone externally on the skull. It seems most unusual that in one part of a neoplasm osteogenesis should occur, while in the other part there is none. Calcification of endotheliomata which are wholly within the cranial cavity, *without bone formation*, is frequent, but the calcium is confined to small deposits called corpora amylacea. Plaques of true bone laid down on the arachnoid membrane have been not infrequently reported, especially in the spinal part of this membrane. (For references see Cushing and Weed, 6.)

To judge from the microscopic appearance of this type of neoplasm in different stages, its growth appears to be as follows:

Derived from inner layers of dura or, more probably from the arachnoid, it is firmly attached to the under surface of the dura. Columns of endothelioma cells are found in the dura, passing through it along the course of blood vessels (Fig. 8). The connective-tissue septa in the layer of tumor between bone and dura are continuous with the tissue of the dura itself (Fig. 4). The neoplasm invades the overlying skull. This is associated with absorption of bone and laying down of new bone. In early cases, that is of a year or two standing, the bone tends to be more porous. In long-standing cases, the bone is usually more eburnated. The whole bone pattern becomes altered, the external table is absorbed and remade so that the outer surface of skull as a rule slopes gradually up on the neoplastic prominence. Endothelioma cells are everywhere filling all the haversian canals and spaces. But there lie between these cells and the bone, cells resembling connective tissue. At the apex of the tumor, beneath the scalp, there is invariably a pad of endothelioma. Here the bone proliferation is most active and here the connective-tissue cells just mentioned are most in evidence, surrounding the newly formed bone spicules (Figs. 4, 23, 24). These spicules may be laid down perpendicularly to the skull (Fig. 11). In some of the cases the endothelioma infiltrates the overlying scalp or temporal muscle and scalp. There may appear small excrescences of bone on the under surface of the skull. The intracranial part of the tumor is not ossified, also grows very slowly, and does not infiltrate brain. In some cases of long standing this intracranial portion is small. In some cases it is found spread out thin over the brain (Fig. 17), in others it is attached to the dura over a small area but enlarged beneath so as to displace large areas of brain (Fig. 7).

The nature of the cells which form a thin strip of many layers covering over the newly forming areas of bone is of considerable interest. The nuclei are elongated at the outside

becoming oval and shorter as the bone is approached. The nuclei are less closely packed than those of the endothelioma so that the tissue appears to stain less deeply. It is evident that these cells have to do with bone formation and they resemble the osteoblasts seen in ordinary bone repair. There are connective-tissue septa running through the tumor which are seen to be continuous in places with the bone-forming cells.

Whence are these cells derived? The connective tissue of dura or bone may have proliferated and grown along with the tumor to assume the function of osteogenesis in this slowly growing neoplasm. On the other hand, one may assume that the cells of the endothelioma have acted as osteoblasts, changing somewhat in appearance during bone formation. As was mentioned above, the arachnoid has been observed to contain bone, and the dura is said to serve as periosteum to the skull. But if the bone is formed by cells derived from the tumor, it is difficult to understand why the intracranial portion of the endothelioma, which is likewise slow in growth, should not form bone also. It seems, therefore, more reasonable to suppose that the osteogenetic cells, which resemble the fibroblasts derived from periosteum and bone tissue during ordinary bone regeneration, are derived either from the outer layers of the dura or from the bone itself.

The manner of growth of these neoplasms is unique. They rarely, if ever, penetrate the pia, but they pass through dura mater and skull and may enter scalp. During the passage through the bone they do not crowd out and destroy all that lies in their path. There is, of course, rarefication of the bone originally overlying the tumor, but the bone-forming cells which are encountered are stimulated to proliferate and to lay down new bone. It is probable that all bone is in a state of flux, the haversian system pattern being constantly altered by absorption and redeposition. This is especially true when the bone is subjected to unusual conditions such as obtain in a fracture. Thus in a certain sense, the neoplasm may be said to respect the function of the tissue invaded. This is true to such an extent that the tumor itself becomes in a large part replaced by bone, a fact that explains why, in reports of these cases, it has usually been taken for granted that the bony prominence was a simple exostosis.

SUMMARY

There is a group of dural endotheliomata which give evidence of their presence and position by a typical, slowly growing, hard prominence on the cranium. The nature of these neoplasms has not been generally understood. They have been called hemicranioses by some authors, in the belief that they were hypertrophies invariably situated in the cutaneous distribution of the first division of the trigeminal nerve. The cranial boss has been frequently considered to be a simple exostosis.

The microscopic picture of these tumors is that of the so-called endothelioma of the dura, their nuclei being frequently arranged in whorls or palisades. They appear to arise from the arachnoidea or inner layer of the dura mater, displacing without infiltrating brain. They pass through the dura in a number of places, enter the overlying bone, and cause a complete rearrangement of the osseous structure. The bone-forming elements are caused to lay down bone in the substance of the neoplasm. This osteogenetic activity is greatest in a pad of endothelioma that comes to lie between skull and scalp, with the result that an osseous tumor forms on the external surface of the cranium and may become very large and hard. The temporal muscle and scalp may be infiltrated with the neoplasm.

Four hundred and twenty histories of cases, in which the diagnosis of brain tumor had been proven at operation or autopsy, were studied and, of these tumors, 11 were found to be associated with a lump on the cranial vault. In one of these 11 cases the lump was soft and could be pressed inward through the skull. This proved to be a sarcoma and could not have been confused clinically with the remaining 10 cases, in all of which the lump was quite evidently a bony prominence of the skull. All of these 10 cases presented the same pathological picture and similar clinical histories.

Operative removal, in cases where the patient survived the immediate effects, has resulted in cures. In most instances, it should be possible to make the diagnosis before the

onset of distressing cerebral symptoms. The characteristic cranial prominence increasing over a considerable period, associated with pain of a stabbing character beneath the tumor, is pathognomonic of the condition.

Whatever may be the etiology of these tumors, the cranial prominence is secondary to invasion of the skull by the intracranial tumor. It is incorrect to suppose that the cranial and intracranial tumors are of entirely different nature. They are the same except that the growth of the former is accompanied by bone formation. It is evident, therefore, that the following hypotheses are incorrect: (1) that a primary thickening of the skull irritates the dura and thus causes the appearance of an intracranial endothelioma, or (2) that some irritation causes the dura to lay down neoplasm on one side and exostosis on the other. It is usually impossible to elicit a history of trauma, and yet the much greater incidence of this type of endothelioma among men than women suggests that trauma may be in some way an etiological factor.

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RENAL FUNCTION FOLLOWING NEPHROTOMY[1]

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BECAUSE of the danger of hæmorrhage and the probable great injury to kidney function following nephrolithotomy, the operation of pelviolithotomy has become the operation of choice, at least in this country, in the treatment of renal calculi. Marion considers nephrotomy indicated when it is impossible to extract calculi by pyelotomy. Lower says that stones which cannot be removed through the pelvis of the kidney must be reached by one or more incisions into the kidney. He advises against bisection of the kidney and considers it best to cut directly over the stone. Binnie quotes Rovsing as saying that the injury to parenchyma following nephrolithotomy is of comparatively little importance. Cathelin asserts that nephrolithotomy is the type of operation which rules for renal calculi. Rehn says that in 10 to 12 per cent of cases of nephrotomy, there are dangerous secondary hæmorrhages or urinary fistulæ. He belives that nephrotomy in itself affects kidney function seriously, and, as a method of averting hæmorrhage, advocates fixation of the kidney and careful drainage of the renal pelvis, in some cases by a ureteral catheter extending from the pelvis of the kidney into the bladder. W. J. Mayo says, "pelviolithotomy is the most generally useful operation for stone in the kidney." Deaver formerly removed nearly all renal calculi by nephrotomy, but he has discarded the procedure in favor of pelviolithotomy because of the danger of hæmorrhage after nephrolithotomy. Marwedel's method of performing nephrotomy, consisting of a transverse incision through the parenchyma of the kidney into the pelvis, has not been considered.

From a review of twenty-one complete nephrotomies performed between 1910 and 1921 at the Mayo Clinic, for various conditions, it was found necessary in four instances (19.5 per cent) to perform a secondary nephrectomy for hæmorrhage within a period of 4 weeks after the primary operation. Nephrotomy was performed for unilateral hæmaturia in 16 cases. The line of incision into the kidney was in the anatomical middle line of the cortex of the kidney in 6, and just posterior to the middle line in 4. The methods of suture used to close the kidney and the type and amount of drainage varied.

The nephrolithotomy was bilateral in 2 of 150 cases observed in the Mayo Clinic. In 1 of these the patient was well 8 years later; the other patient had a recurrence of stone. Unilateral nephrolithotomy was followed or preceded by a nephrectomy of the other kidney in 6 cases. Five of the patients were alive and well 5 years after operation; the other was well for 3 years and then died. It was necessary to perform a nephrectomy because of hæmorrhage in 2 of the 150 cases. In 3 it was necessary to remove the kidney which had been subjected to nephrolithotomy because of infection in the kidney. This infection was, of course, present to a degree before the nephrolithotomy was performed.

CASES ILLUSTRATING THE AMOUNT OF FUNCTION PRESENT AFTER INCISION OF THE KIDNEY

Case 1. (A108397.) A left nephrolithotomy was performed June 30, 1914, with removal of two stones; one in the upper pole was branched. The wound was closed without drainage. August 26, 1914, the right kidney was removed for pyonephrosis. At this time the phenolsulphonephthalein test revealed 60 per cent secretion in 2 hours. In 1915 the patient had an acute perforation of a duodenal ulcer, resulting in a duodenal fistula which was repaired. In 1917 the phenolsulphonephthalein excretion was still normal, and in 1921 the patient wrote that he was "feeling fine," with no untoward symptoms.

Case 2. (A581175.) A left nephrolithotomy and pelviolithotomy were performed in 1911; 11 days after operation it was necessary to remove the left kidney because of uncontrollable secondary hæmorrhage. In 1913 a large branched stone was removed from the right kidney by nephrotomy. The phenolsulphonephthalein excretion in 1915 was 47 per cent in 2 hours, and in 1919, 50 per cent. The patient was in excellent condition in 1921.

[1] From the Division of Experimental Surgery and Pathology, and the Section on Urology.

Fig. 1.

Fig. 1 (at left). Roentgenogram of human kidney with arteries injected with barium sulphate solution.

Fig. 2.

Fig. 2. Roentgenogram of dog's kidney with arteries injected with barium sulphate solution.

CASE 3. (A58173.) A right nephrolithotomy was performed in 1911. October, 1916, the pelvis of the left kidney was opened, but no stone found. A month later a left nephrolithotomy was performed and a stone removed from the inferior calyx. The renal wound was closed with one tube drainage. In 1920, the left kidney was again incised in two places and two stones were removed. The kidney appeared to be inflamed. The phenolsulphonephthalein excretion in 1922 was 40 per cent in 2 hours, and the blood urea was 36 milligrams for each 100 cubic centimeters of blood. At this time there was a recurrence of stones in both kidneys with a 15 per cent return of phenolsulphonephthalein from the left kidney in 15 minutes and 4 per cent in the right kidney. The function of the right kidney seemed to be greatly reduced.

Fig. 3.

Fig. 3 (at left). Roentgenogram of human kidney with arteries injected with barium sulphate solution. View from the pole.

Fig. 4.

Fig. 4. Roentgenogram of dog's kidney with arteries injected with barium sulphate solution. View from the pole.

CASE 4. (A169613.) In 1916, one large branched stone and a smaller stone were removed from the upper pole of the right kidney by nephrolithotomy. The function before operation, as estimated by the excretion of phenolsulphonephthalein, was 15 per cent in 15 minutes, from the right kidney, and 14 per cent in 15 minutes from the left kidney. July 21, 1917, 1 year after operation, the excretion was 12 per cent in 15 minutes from the right kidney, and 22 per cent in 15 minutes from the bladder.

CASE 5. (A338142.) A right nephrolithotomy was performed November 27, 1920. The kidney was split from pole to pole. The renal wound was drained with two tubes. May 20, 1922, the left kidney was removed for extensive infection. October 31, 1920, the phenolsulphonephthalein excretion before nephrolithotomy was 10 per cent in 15 minutes from the right kidney. As the elimination of phenolsulphonephthalein was 25 per cent in 1922, and the left kidney was functionless, there must have been considerable increase in function of the right kidney following nephrotomy.

EXPERIMENTAL WORK

In a masterly work Tuffier demonstrated that 1.5 grams of secreting kidney parenchyma for each kilogram of animal weight was compatible with the life of the animal. Thus he was among the first to believe and to show that life may exist with considerable loss of the substance of kidney. By conducting a series of experiments he found that the best way to incise the kidney and to suture the renal wound is to cut through the convex border of the kidney leading into the pelvis, and to close with four to six deep sutures through the medulla, tying them over the cortex. Between

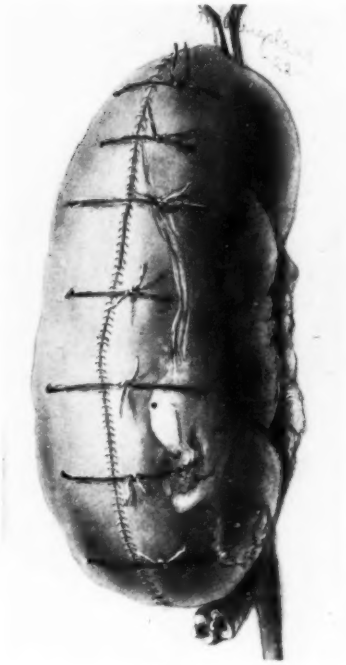

Fig. 5.

Fig. 6.

Fig. 5 (at left). Suture of nephrotomy wound by deep sutures tied over the cortex.
Fig. 6. Suture of nephrotomy wound by three mattress sutures and continuous suture of fibrous capsule.

these, superficial sutures are placed and tied in the same manner. Tuffier concluded, from a microscopical study of the nephrotomy wounds, that it is possible to suture the wound and obtain union by first intention without injuring the structure or function of the remainder of the gland.

Cullen and Derge quote Broedel as saying: "In man and the dog there are as a rule two main arterial trunks supplying the kidney, one passing to the anterior and the other to the posterior portion." Cullen and Derge conducted a series of experiments in which they performed nephrotomy in the avascular line as advised by Broedel, using both the knife and silver wire for incising, and cutting from without in and from within out. They studied the amount of blood lost in these various procedures and the character of the scars produced. The wounds were closed with a single row of mattress sutures of fine black silk. The authors conclude that the value of the silver wire lies more in the rapidity with which hæmorrhage stops and the ease with which it may be controlled than in the actual amount of blood lost in a given time; also that the wounds produced by the wire cutting from within out heal more readily and with less destruction of tissue than those produced with the knife.

Moore and Corbett say that nephrotomy always results in some destruction of kidney substance. They performed a series of experiments on rabbits in which they incised the kidney from pole to pole in the median line, extending through the kidney substance. The wounds were sutured by (1) continuous suture of the capsule only, (2) continuous mattress suture parallel to the wound, and (3) interrupted sutures traversing the kidney and tied over the cortex. Three sutures were generally used. The animals were killed at the

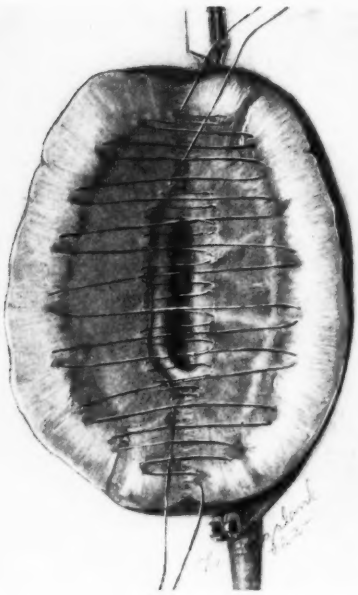

Fig. 7.

Fig. 7. Suture of nephrotomy wound with two layers of running mattress sutures.

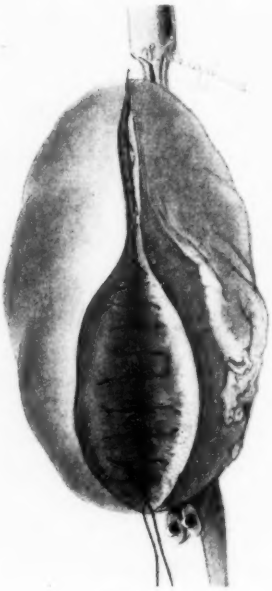

Fig. 8.

Fig. 8. Same as Figure 7, with lower suture drawn taut.

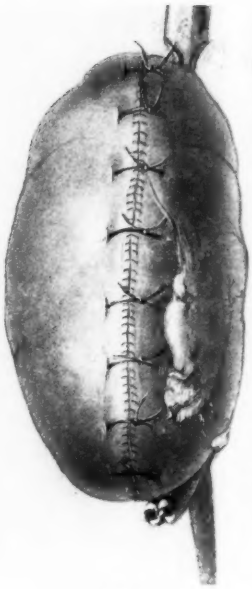

Fig. 9.

Fig. 9. Same as Figure 8, wound closed.

end of 10, 37, and 90 days, and the wounds carefully studied.

Moore and Corbett conclude that (1) an operation on the kidney always destroys a certain amount of kidney substance; (2) the section of the kidney does less harm than the

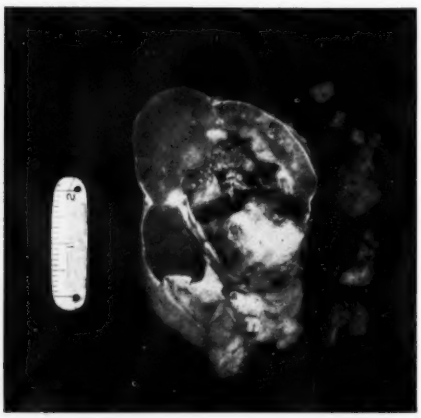

Fig. 10. Cross section of kidney subjected to nephrotomy, showing infected substance and stone formation.

Fig. 11. Partly healed nephrotomy incision, 7 days after operation.

Fig. 12. Cross section of nephrotomy incision, 7 days after operation.

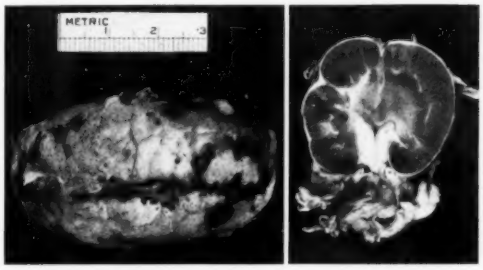

Fig. 13. Fig. 14.

Fig. 13 (at left). Kidney, 3 months after nephrotomy.
Fig. 14. Cross section of kidney shown in Figure 13.

suture necessary to control hæmorrhage; (3) suture of the capsule alone is not sufficient to control hæmorrhage; (4) mattress sutures

TABLE I.—SERIES I, II AND IV

Dog No.	Normal weight, kg.	Normal condition of animal	Type of suture for nephrotomy	Length of life, months	Complications	Weight at end of experiment, kg.	Condition of animal at end of experiment	Remarks
				SERIES I				
152	9.7	Good	Double mattress	4	None	11.3	Good	Left kidney weighs 30.5 gm., nodular. Depression at line of incision, destruction of tissue around scar, kidney cells in fair condition. Right kidney weighs 30 gm. Depression at line of incision. Kidney cells in good condition.
153	10.3	Good	Deep sutures tied over cortex	4	Uræmia	9.0	Fair	Left kidney weighs 17.5 gm., contracted, marked degeneration of kidney tissue. Right kidney weighs 18 gm., contracted, marked degeneration.
509	9.9	Good	Double mattress	0.4	Hæmorrhage		Poor	Left kidney weighs 90 gm., practically destroyed from hæmorrhage. Right kidney weighs 29 gm., blood clot in line of incision. Kidney cells in poor condition.
				SERIES II				
163	8.7	Good	Double mattress	9 (still alive)	Gave birth to three puppies	8.9	Excellent	None
120	8.9	Good	Double mattress	10 (still alive)	None	10.2	Excellent	None
				SERIES IV				
390	12.8	Fair	Mattress	4 (still alive)	None	10.0	Good	None
525	15.3	Good	Double mattress	4	None	13.7	Good	None
391	10.9	Fair	Double mattress	4	Death, 9–21–22	Last weight 7–20–22 9.1	Poor	Right kidney weighs 40 gm., deeply scarred with acute pyelonephritis. Much destruction of kidney substance, replacement with connective tissue and round cells. Kidney cells generally in poor condition. Left kidney weighs 33.5 gm.
52[illegible]	17.8	Good	Double mattress	3	Death, 9–18–22	Last weight 7–18–22 16.2	Good	Incision healed nicely; microscopically the kidney was generally in good condition.

TABLE II.—SERIES III

Dog No.	Normal weight, kg.	Normal condition of animal	Type of suture for nephrotomy	Length of life, months	Complications	Weight at end of experiment, kg.	Condition of animal at end of experiment	Remarks
				SERIES III				
219	15.2	Good	Deep sutures tied over cortex	4	Stone formation, uræmia	13.7	Good	Left kidney weighs 71 gm., contains multiple stones, posterior portion atrophic, general poor condition of kidney substance.
130	7.1	Good	Double mattress	8	None	7.0	Excellent	None
625	8.6	Fair	Mattress	3	Uræmia	6.9	Fair	Left kidney weighs 25 gm., generally in poor condition. Right kidney weighs 27.5 gm. in poor condition after nephrectomy.
249	9.2	Fair	Deep sutures tied over cortex	3	Gave birth to three puppies	8.4	Good	Left kidney weighs 26.5 gm., fairly good condition. In general the kidney substance seems to be in rather poor condition. Right kidney weighs 26.4 gm.
627	7.2	Fair	Mattress	0.53	Uræmia		Poor	Left kidney: blood clot in line of incision, areas of necrosis, marked degeneration of kidney substance.
218	9.7	Good	Double mattress	0.3	Uræmia, hæmorrhage		Poor	Left kidney weighs 37 gm., line of incision in medulla necrotic. Kidney substance shows marked degeneration.
110		Poor	Double mattress	0.2	None		Fair	Right kidney weighs 24 gm., incision healing nicely. Kidney cells in good condition.
191	13.3	Good	Double mattress	3	Stone formation	11.5	Good	Kidney contained stones, no further pathological condition ascertained. Cause of death unknown.
248	10.4	Fair	Double mattress	0.1	Uræmia, primary hæmorrhage		Poor	Left kidney weighs 81.2 gm., hæmorrhage from cortex, with separation of incision. General degeneration of kidney substance.
129	14.2	Good	Deep sutures tied over cortex	0.37	Uræmia		Very poor	Right kidney, general poor condition, areas of anæmic infarcts and infection. Bladder and left ureter filled with pus.
92	9.9	Good	Double mattress	5	None	11.0	Excellent	Right kidney weighs 40 gm., in fair condition, areas of destruction with replacement by fibrous tissue and round cells. Kidney substance in fair condition.
99	13.0	Good	Double mattress	5	Stone formation	10.0	Fair	Right kidney weighs 43 gm., nodular, generally in fair condition. Stone in pelvis.
556	8.0	Good	Mattress	3	None	8.5	Good	Left kidney weighs 35 gm., in good condition grossly and microscopically. Right kidney weighs 30.5 gm., in good condition.
250	7.6	Good	Double mattress	3	Stone formation	7.5	Fair	Left kidney weighs 29 gm., grossly in fairly good condition, areas of destruction, with fibrous replacement and areas of leucocytes. Incision replaced with scar tissue. Kidney cells in poor condition. Right kidney weighs 21 gm.

destroy a great deal of kidney substance, and the enlargement of the kidney after a short time is due to overwork and not to increased kidney substance, showing that the sum total of kidney substance is reduced by the operation; (5) the destruction of the kidney substance extends far beyond the site of the operation; (6) the functional activity of the kidney operated on is somewhat reduced (the functional activity is determined by estimating the amount of urine secreted and its nitrogen balance), (7) the interrupted sutures caused the least damage, and (8) histologically, great damage was done to the kidney substance.

METHOD OF EXPERIMENTATION

All of my experiments were performed on female dogs. The normal kidney function was established before operation, and the general condition of the animal and its weight noted. The operative procedures were all conducted under ether anæsthesia, employing sterile technique. The kidney was delivered

Fig. 15.

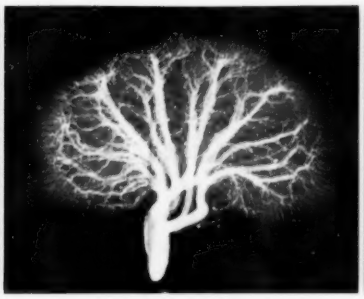

Fig. 16.

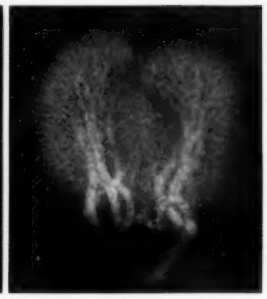

Fig. 17.

Fig. 15. Roentgenogram of dog's kidney subjected to nephrotomy with arteries injected with barium sulphate.

Fig. 16. Roentgenogram of dog's kidney after nephrotomy, with the arteries injected with barium sulphate.

Fig. 17. Roentgenogram of a dog's kidney after a nephrotomy, with the arteries injected with barium sulphate.

through a lumbar incision, a rubber-covered clamp was applied to the pedicle and the organ incised from pole to pole. The incision was closed by various methods which will be described, and the wound closed with layer sutures. Following operation the dogs were carefully observed with particular reference to blood in the urine. At intervals they were weighed, examination of the urine was made, and the functional activity of the kidney was determined. Certain of the animals were killed by etherization at intervals varying from 10 days to 6 months. The gross condition of all the kidneys was studied, and microscopic sections were made to ascertain the character of the scar, amount of destruction, and the condition of the tissue at a distance from the line of incision. The kidney function was estimated by determining the blood urea and the excretion of phenolsulphonephthalein. The routine procedure was as follows:

The animal was placed on the standard diet of the laboratory kennels. Blood was withdrawn from the jugular vein. The urea content of the blood was estimated by Van Slyke and Cullen's modification of the Marshall method. One cubic centimeter of phenolsulphonephthalein was injected into the dog's jugular vein, and it was placed in a metabolic cage for 2 hours and 15 minutes. It was given water to drink during this time. All urine excreted was collected at the end of 2 hours and 15 minutes; the animal was then catheterized with a sterile steel catheter, and the bladder lavaged with warm water. All the urines were mixed and the percentage of phenolsulphonephthalein excreted was determined by the use of standards and with the colorimeter. Two urea and two phenolsulphonephthalein tests were made on each animal before operation. The same procedure was carried out at intervals after the nephrotomy. In some cases the amount of urine passed during stated intervals was determined and a chemical and microscopical analysis made.

Site of operation on the kidney. It is known from the work of Hyrtl, Zondek and Broedel that the place of election in incising the human kidney is in the avascular area just posterior to the middle convex line. Cullen and Derge and Kelley assert that the blood supply in the dog is similar to that of man with the exception that, in most dogs, the larger artery passes to the posterior portion of the kidney rather than to the anterior, as in man. In order to corroborate this finding, kidneys, taken fresh from dog and man, were washed clear of blood and injected with barium sulphate solution according to the technique of Gross. Roentgenograms were then made and the vascular network was studied. It was seen that in the kidneys of dogs, the avascular area was larger than in the kidneys of man and in the middle portion of the kidney (Figs. 1, 2, 3, and 4), and that an incision made through this area in the dog would probably cut fewer arterioles than an incision in the avascular zone of the kidney of man. Therefore, the incision used in my experiments was made in

Fig. 18. Incisions for nephrotomy in man and the dog.

the middle convex line, or just anterior or posterior to it. The scalpel was used in all cases. The kidney was delivered through a lumbar incision and a rubber-covered clamp applied to the pedicle. The kidney was then incised as described, and its wound closed in three ways: (1) three or four deep sutures were passed through the kidney substance and tied over the cortex and a continuous suture was applied through the fibrous capsule (Fig. 5); (2) three mattress sutures were placed through the medulla and a continuous suture through the fibrous capsule (Fig. 6); and, (3) two rows of continuous sutures placed at different levels, one near the pelvis of the kidney and the other at the juncture of the medulla and the cortex, just entering the kidney substance on each side, as suggested by Mann. The ends were tied at one pole and the two halves of the kidney brought together. The two sutures were pulled up and tied, and several stay sutures applied to the fibrous capsule and finally a continuous suture through the fibrous capsule (Figs. 7, 8, and 9). No. 00 catgut was used in all renal sutures.

RESULTS

Four series of experiments were conducted: (1) bilateral nephrotomy at one operation; (2) bilateral nephrotomy with an interval between the two operations; (3) removal of one kidney and a nephrotomy later on the remaining kidney, and (4) unilateral nephrotomy and after an interval removal of the other kidney.

The normal condition and weight of the animals, the type of suture used in closing the nephrotomy wound, the complications and length of life of the dog, and the condition of the animal and its weight at the end of the experiment are given in Tables I and II. The pathological condition of the kidneys as found at necropsy is briefly indicated. The dogs were in good condition in nearly all instances. Continuous mattress sutures were employed in seventeen operations, the deep sutures over the cortex in five, and the mattress type of suture in four. The complications following the continuous mattress sutures were: uræmia, two; hæmorrhage, three; considerable loss of function, two, and stone formation, three. Thus, in seventeen operations there was considerable loss of function in four cases and hæmorrhage in three. In the five experiments in which deep sutures were tied over the cortex, uræmia occurred in three animals and stone formation (Fig. 10) in one of the three. In the experiments in which mattress sutures were used, uræmia occurred in two. Hæmorrhage did not occur with the latter types of suture. In a number of instances, blood was present in the urine immediately after operation; it disappeared in a day or two and no attention was paid to it as it appeared to be a natural sequence to such an operation. Eleven of the animals lost weight; the weight of one remained stationary, and five gained weight.

In general the kidney showed considerable pathological change. The substance of the kidney was depressed along the line of incision in nearly all cases, and many of the kidneys were nodular. In a few instances there was considerable loss in the weight of the nephrotomized kidney when compared with the opposite kidney. The incisions in the dogs killed soon after operation were replaced with blood clot (Figs. 11 and 12), with degeneration of nearby kidney tissue. Later the clot was replaced by scar tissue, as seen in the kidneys of animals killed after a longer period (Figs. 13 and 14). In nearly all, the substance of the kidney in the region of the incision showed destruction of tissue and replacement with round cells and fibrous connective tissue. The microscopical change of

TABLE III.—SUMMARY OF BLOOD UREA ESTIMATIONS AND PHENOLSULPHONEPHTHALEIN TESTS ON TWENTY-THREE DOGS

Dog No.	1* 2**	Normal	Time after operation										
			Two Days	Four Days	One week	Two weeks	One month	Six weeks	Two months	Three months	Four months	Five months	Eight months
SERIES I													
509	1	30	36			116							
	2	70	60			10							
153	1	28	40			98	94	106	90	126	162	144	
	2	50	65			45	45	40	50	30	30	30	
152	1	36	32			42	58	60	48	36	34	22	
	2	35	50				50	45	40	35	60	45	
SERIES II													
120	1	48	46			70	54	32	28	80	28	46	18
	2	60	55			55	45	55	55	55	50	50	60
163	1	26	40			44	28	36	44	30	22	36	32
	2	50	55			45	50	50	50	40	60	40	45
SERIES III													
556	1	34	32	42			42	24	64	34	34		
	2	65	65				62	60	50	60	65		
99	1	56	70		140	100	68	68	52	46	88	50	
	2	55	55			20	35	60	50	40	35	40	
92	1	52	52		66	68	80	48	66	40	38	22	
	2	60	80		70	50	50	65	50	55	55	60	
129	1	36	32			414	594						
	2	70	70			None	None						
248	1	46	46		422								
	2	65	60										
191	1	40	34			68	50	44	44	42			
	2	70	70				40	45	55	65			
110	1	46	48		72	76							
	2	40	50		60	55							
218	1	52	52			352							
	2	60	55										
627	1	30	36	38			460						
	2	60	60										
249	1	46	32			36	60	44	66	38	38		
	2	60	50				55	55	45	50	50		
625	1	66			50		80	84			84		
	2	30					25	25	30		30		
130	1	32	32			76	64	48	32	70	34	40	20
	2	65	65			50	55	45	45	30	50	60	60
219	1	36	40			94	62	26	46	68	108		
	2	60	60			50		50	45	35	None		
250	1	48	44		106	80	76	70	56		36		
	2	60	55			55	50	50	45		45		
SERIES IV													
525	1	14			28						24	22	
	2	60			60		60					60	
391	1	16	8	22		34			24				
	2	60		50		60			50				
524	1	22			34		54				50		
	2	50			50		50						
390	1	32	15	36		38			26			28	
	2	60		50		55			55			50	

*Blood urea estimations, milligram for each 100 cubic centimeters.
**Phenolsulphonephthalein, per cent return in two hours and fifteen minutes.

TABLE IV.—SUMMARY OF TWENTY-SIX NEPHROTOMIES ON TWENTY-THREE DOGS

	Dogs
Stones occurred in	4
Hæmorrhage occurred in	3
Secondary	2
Consecutive	1
Uræmia occurred in	7
Associated with hæmorrhage in	2
Associated with stones in	1
Temporary change in function with return to normal in	9
Slight change in function occurred in	5
Moderate change in function occurred in	2
Great change in function occurred in	7

the substance of the kidney usually followed the functional results; if there was a diffuse degeneration of the kidney cells, the functional loss was great, and vice versa. With all types of suturing, streaks of fibrous tissue were seen along the suture line. This appeared to be greatest in the kidneys in which the mattress sutures were used.

Table III gives in detail the functional tests before and after nephrotomy, Table IV contains a summary of the complications and functional results in 26 nephrotomies performed on 23 dogs.

Hæmorrhage occurred three times, one of the primary and one of the secondary type. Stones were found in the pelvis of the kidney in 4 and uræmia in 7. The latter was associated with hæmorrhage in two instances and stone formation in one. There was a temporary change in function following operation with a return to normal in 9. Five animals showed slight loss of function; 2, moderate loss, and 7, great loss.

In Dogs F99 and F249, the renal artery was injected by the Gross method after nephrotomy. The depression along the line of incision was evident. However, there did not appear to be any appreciable interference with circulation (Figs. 15 and 16). A large soft stone was situated in the pelvis of the kidney of Dog F99 and failed to show (Fig. 17). This kidney was closed by the double mattress technique and there was only slight loss in function. The roentgenograms of the kidney of Dog F249 also showed no interference with the blood supply. This kidney was closed with four deep sutures tied over the cortex and there was practically no loss in function.

DISCUSSION

Clinical results. Hæmorrhage requiring secondary nephrectomy occurred in 4 of 21 cases of complete nephrotomy for conditions other than stone, chiefly for exploration, while in 150 nephrolithotomies a secondary nephrectomy for hæmorrhage occurred only twice. This would appear natural as it is reasonable to suppose that a bleeding kidney would be more subject to hæmorrhage after operation than a non-bleeding one, and as in the cases of stone the incisions into the kidney are of less extent. It was necessary, however, to perform a secondary nephrotomy for infection in 3 cases and for a recurrence of stones in 2. On the other hand it is evident that a single kidney may be subjected to nephrolithotomy and maintain a fair degree of function and support life.

Experimental. Because of the difference in the arterial supply of the kidney in man and dog, the plan of incision to avoid injury to the vessels necessarily differs. The incision as advocated by Broedel is the one of choice for man, while incision in the middle line of the cortex, cutting straight down into the pelvis, will cause the least injury in the dog (Fig. 18).

Hæmorrhage, although occurring in only 12 per cent of nephrotomies, is a real danger. It is associated with destruction of kidney tissue and kidney insufficiency. Kidney insufficiency, however, may occur without hæmorrhage, resulting from a general degeneration of tissue, contraction of the kidney and, in a small number, true infection. It is true, however, that in the greater percentage of cases, except those of hæmorrhage and infection, the operation does not appreciably destroy the renal function. The kidney may be very nodular, its form much distorted, and there may be considerable contracture, but unless there is an associated general degeneration of kidney cells, the function continues

fairly good. This would seem to show that it is not localized multiple areas of destruction that destroy function, but a diffuse degeneration.

The results from the various methods of suturing would indicate that the double mattress type of suture is followed by the best functional results, but the danger of hæmorrhage and stone formation appear to be slightly higher than with the other two methods of suture.

Because of the possibility of hæmorrhage and infection, the operation of nephrotomy, or especially nephrolithotomy, appears to be inferior to that of pelviotomy and pelviolithotomy. Nephrolithotomy is, however, indicated in such cases in which the stone is situated at the end of a calyx or partially protruding into the cortical substance, and particularly when there is infection and with comparatively little danger of secondary hæmorrhage.

CONCLUSIONS

1. The arrangement of the arteries of the kidney differs in man and dog.

2. Complete nephrotomy, bilateral or unilateral, may be performed in dogs with maintenance of life and renal function. A single kidney may be subjected to nephrolithotomy and maintain sufficient function to support life and health.

3. Secondary hæmorrhage is a real danger in complete section of the kidney. Smaller incisions, single or multiple, may be made into the kidney to remove stone, with small risk of secondary bleeding.

4. Generally pelviotomy is the operation of choice in the treatment of renal calculi; however, in selected cases, nephrolithotomy is indicated.

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TRAUMATIC ASPHYXIA; WITH ESPECIAL REFERENCE TO ITS OCULAR AND VISUAL DISTURBANCES

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ON November 3, 1917, Sergeant Z., age 31, was crushed beneath an overturned motor truck, and suffered a violent compression injury of his lower thorax and abdomen. He was extricated by his companions, and after being examined at Field Hospital No. 12, was immediately sent to Base Hospital No. 18 (France).

On admission he was conscious and answered questions quickly and intelligently. He complained of pain about his pelvis and of inability to void. On examination the attention was immediately directed to his face, which was markedly œdematous and of an intense, deep violet color. This discoloration extended over the entire face up to and within the hair line, involved the ears and the neck, and extended down upon the upper thorax, where, however, it was less intense and interrupted by steaks of normal skin. Upon this violet background were numerous petechial hæmorrhages. The eyes were closed and could not be voluntarily opened, due to the excessive œdema of the lids. On forcibly separating the lids, there appeared a complete bilateral subconjunctival ecchymosis. The lips were greatly swollen and bluish black. The discoloration involved to some extent the tongue and mucous membranes of the mouth and the external auditory meatuses.

Examination of the thorax failed to show any serious injury. Fracture of a rib could not be determined. The respirations were deep, slow, and slightly labored, the pulse strong and not especially accelerated. Examination of the abdomen showed a visible and palpable tumor in the bladder region. Pressure about the pelvis was very painful, especially upon the left side. Voluntary movements of the lower extremities were possible but painful. On catheterization a large amount of bloody urine was withdrawn from the bladder. An X-ray plate of the pelvis showed a fracture of the left pubis and ischium with slight displacement of the fragments.

The patient was operated upon by me the day of his admission. A midline incision was made between the umbilicus and symphysis pubis and the greatly distended bladder opened widely. After the evacuation of a large amount of fluid and clotted blood, a ragged tear in the left bladder wall 4 centimeters in length was found, through which blood from an active hæmorrhage about the fracture entered the bladder. The fracture could be felt through the rent in the bladder wall, but the exposure was so difficult that the hæmorrhage about the fracture could not be satisfactorily controlled. The tear in the bladder wall was closed by catgut sutures introduced from within the bladder. The anterior incision in the bladder was closed without drainage. Extravesical tamponade was used to control the hæmorrhage about the fracture. The pelvis was fixed by strapping with wide strips of adhesive.

With the exception of a troublesome bronchitis with bloody expectoration for a few days, the patient made an uneventful recovery. Not until several days after the operation had the swelling of the lids subsided sufficiently to enable the patient to open his eyes, and then he found that he was unable to see distinctly. An immediate ophthalmoscopic examination showed a bilateral retinal œdema and massive hæmorrhages scattered over each disc and macular region. Dr. Lloyd Whitham, then ophthalmologist to Base Hospital No. 18, confirmed my observations, and to him I am indebted for many subsequent notes. Tested roughly, the patient could recognize the approach of an individual but could not recognize him by his features, was unable to count fingers, and could scarcely recognize large masses of color. Even such slight vision declined during his stay at the Hospital and he eventually became quite blind, excepting for a tiny area in the right infero-temporal visual field which could be quite clearly mapped out by Dr. Whitham with the perimeter. The retinal hæmorrhages were slowly absorbed and the gradual atrophy of the discs, manifested particularly by attenuation of the vessels and paleness, was quite evident at time of his discharge.

This tragic result, so far as the patient's vision is concerned, made a great impression upon me at the time but in the stress of subsequent work the whole experience was forgotten. It was recalled by the visit of the patient 2½ years later in Baltimore. He had been sent home from France, for a time had been at the school for the blind at "The Evergreens," Baltimore, and had become a skilled masseur. An examination made in May, 1920, showed a strong healthy man, but one, who, unfortunately, has remained completely blind.

It is not our purpose to review the entire subject of traumatic asphyxia, but rather to confine ourselves to the visual disturbances associated with this condition. We shall, however, briefly summarize the salient features of the condition and then take up in some detail its associated ocular manifestations and visual disturbances. For a full exposition of the subject, reference may be made to the appended literature.

1. CLINICAL SUMMARY

(a) Traumatic asphyxia (*Druckstauung*, Perthes) (*Stauungsblutungen nach Rumpf-*

kompression, Braun) (*Masque ecchymotic*, French clinicians) (Pressure stasis, traumatic apnœa, etc., English and American) is a condition produced by violent compression of the thorax or upper abdomen or both. In all the cases reported in the literature the compressing force has been applied either directly, the individual being crushed under a wagon or other heavy weight, between two parts of a machine, between cars, or by other individuals in a panic; or indirectly, the individual being doubled up by a force which is exerted upon the shoulders or back, bringing the chest in forcible contact with the thighs and knees ("jack-knife" injury). The compressing force is exerted only for a short time (a few seconds to 5 or 10 minutes). The head and neck are not directly injured.

(b) The characteristic lesion from which the condition derives its name is the discoloration of the face and neck. All the cases described in the literature exhibited to a marked degree a deep blue, violet blue, or bluish black discoloration of the face and neck. On first examination this discoloration or "cyanosis" appears uniform, but closer inspection when made has shown in the majority of instances that the bluish background is studded with minute ecchymotic spots or petechial hæmorrhages. The discoloration is usually most marked about the lids, the lips, and the nose; less marked about the ears and neck. It may involve the scalp within the hair line, or extend to, but not within, the hair line. In some instances the discoloration has involved the mucous membranes of the mouth; but more commonly the mucous membranes of the mouth, the tongue, the faucial pillars, the auditory meatuses, and ear drums have been marked by small punctiform hæmorrhages. While this discoloration has, in the majority of cases, involved the face and neck, it has extended downward upon the upper thorax as far as the nipples, upon the upper arm as far as the insertion of the deltoid, and upon the back to the lower border of the scapula. Here, however, the discoloration has never been so deep as upon the face and neck, and usually has been irregular, being interrupted by streaks of normal-appearing skin. In a number of cases (22) the discoloration has been strikingly absent at a point of pressure, as under a collar band, hat band, or suspenders, an observation which has led to the theory that counter-pressure or support of tissues may protect various structures, as the brain and eye, from injury. The discoloration begins to disappear usually on the second to the fourth day and has quite disappeared within 2 weeks. The color appears simply to fade and does not exhibit the chromatic changes seen following the usual subcutaneous hæmorrhage. This observation, repeatedly verified, suggests that the discoloration, presumed by some to be due to an extravasation of blood into the tissues, is due rather to a marked venous stasis.

(c) In addition to the discoloration, there is usually a marked swelling and œdema of the tissues of the face, especially of the lids and lips. Extensive subconjunctival hæmorrhages, usually bilateral, have been noted in practically every instance. In contradistinction to the discoloration of the face, these hæmorrhages during their absorption exhibit the usual chromatic changes. Hæmorrhages from the nose and mouth are noted in 17 of the 127 cases in the literature; and from the ear, associated sometimes with rupture of the ear drum, in 11 cases.

(d) Unconsciousness is specifically noted to have occurred in 44 of the cases. In the vast majority of cases it has been of very short duration. In 4 cases it persisted from 1 to 7 hours; in one case it continued for 2 days. Signs of cortical irritation have been noted in 8 cases, manifested by convulsive movements, restlessness, and irrationality. Associated fracture of the skull has not been noted; nor any symptoms to indicate pressure from an intracranial hæmorrhage.

(e) Other associated lesions have, of course, varied greatly. *Fractures of one to five ribs*, presumably the result of the compressing force, have been noted in 32 cases, fractures of the clavicle in 6 cases, and of other bones (jaw, humerus, radius, pelvis, femur, tibia) in 10 cases. *Symptoms and signs of intrathoracic injury* have been rather common, but as a rule have been slight and have rather promptly disappeared. Hæmoptysis has been noted in 16 cases; signs of pulmonary œdema,

as indicated by frothy sputum and bubbling râles, in 8 cases; hæmothorax in 3 cases. Pneumonia has occurred in 4 cases, in 1 followed by empyema and in 1 by multiple pulmonary abscesses. Pleural effusion followed by empyema occurred in 1 case. Open thoracic wounds have been noted only once. Subcutaneous emphysema has occurred in 7 cases.

Associated *abdominal lesions* have been clinically rather uncommon. Perforating wounds of the abdomen with prolapse of the omentum and intestine were observed by Pierce and Hueter. An exploratory laparotomy was done upon Wiener's case by Depage, who found a hæmoperitoneum, laceration of the spleen, and thrombosis of the vessels of the mesocolon with necrosis of 5 centimeters of the transverse colon. Abdominal pain, rigidity, and vomiting have been noted in a rather small number of cases but have spontaneously disappeared. Injury to the bladder as in our case has not been previously observed, although bloody urine has been noted in one or two instances.

Associated injuries to the extremities we find have included contusions and lacerations and fractures of the various bones. *Cord and peripheral nerve injuries* have been noted in 8 cases. In von Morian's and in one of our cases there was a presumed or certified injury of the spine and cord. Von Morian's case showed a paralysis of the left and weakness of the right leg without sensory disturbances. The condition eventually spontaneously disappeared. Our case showed a prominence in the region of the twelfth dorsal vertebra, complete paralysis of the legs, and marked loss of sensation. A laminectomy showed a fracture of the twelfth dorsal vertebra and laceration of the cauda equina. He completely recovered. Wegner's case showed weakness of the right arm and leg which subsequently disappeared and suggests a central injury. Braun's (paralysis right tibialis anticus muscle), Ettinger's (paralysis right arm), Despard's (paralysis both arms), Stokes's (flaccid paralysis left arm), and Anderwert's (paralysis left radial nerve) cases are apparently examples of peripheral nerve injuries.

2. PATHOLOGICAL SUMMARY (NECROPSY FINDINGS)

(a) *Brain and meninges.* The brain and meninges have singularly escaped injury. Aside from cerebral congestion indicated by engorgement of the pial vessels, Ollivier found a subdural hæmorrhage in only 1 case of the many examined by him. Tardieu failed to find any cerebral lesions in the 2 cases in which examination of the brain was permitted. Braun, Niemann (necropsy by von Recklinghausen), Orth, Bolt, and Robertson in the necropsies upon their cases found nothing noteworthy aside from cerebral congestion. Schultze's case showed a thin film of blood over the hemispheres but no demonstrable rupture of the cortical vessels.

(b) *Tissues of the face and neck.* The characteristic discoloration of the face and neck has been described. The question has naturally arisen whether this is due to an extravasation of blood into the tissues, the result of rupture of the overdistended vessels or to a prolonged venous stasis with paralysis of the vessel walls. Examination of the discolored skin has been made by Beach and Cobb, Winslow, Bolt, Robertson (2 cases), and Braun. The skin has been excised from the neck or chest of living subjects. Beach and Cobb reported that the examination of numerous sections of skin from the neck failed to show any blood in the tissues outside the capillaries. Winslow states that the capillaries were more or less distended but that there was no blood in the tissues outside the capillaries. Bolt found that in a number of sections the skin was normal, confirming the findings of Beach and Cobb and Winslow; but a careful study of further sections showed a few red cells in the tissues outside the blood vessels. Robertson, in the first case he examined, failed to find any hæmorrhage into the tissues but noted a perivascular infiltration in the cutis vera. In a second case examined by him he found blood pigment in, and hæmorrhage and œdema of, the deeper layers of the corium and subcutaneous fat. Braun (examination of skin by Aschoff) found blood in the tissues of the skin outside the blood vessels.

Necropsy examinations, while giving little information regarding the skin, would indicate

that hæmorrhagic infiltration of the tissues occurs as a result of the pronounced venous stasis. In Braun's case there was extensive bloody infiltration of the soft parts of the head, face, mouth, and intramuscular tissues of the neck. In Niemann's case there was a hæmorrhagic infiltration of the tissues of the head, temporal muscles, mucous membranes of pharynx and neck; in Milner's case, of the pharynx and upper larynx, and in Lang's case of the muscles of the head and neck. The clinical observation that the discoloration of the face and neck disappears without chromatic changes and the failure in most instances reported to find extravasation of blood into the skin, would indicate that the discoloration is due rather to a venous stasis than an extravasation of blood into the tissues. The matter, however, requires further study.

(c) *Thorax.* The intrathoracic necropsy findings have been as follows:

Braun's case. Left hæmothorax. Extensive bloody infiltration of the subpleural space, posterior mediastinum along the aorta and right diaphragm. Diaphragm torn from its attachment.

Niemann's case (necropsy by von Recklinghausen). Hæmothorax, subpleural and pulmonary hæmorrhages, fat emboli in the pulmonary arteries.

Lang's case. Rupture of the right lung. Hæmothorax.

Milner's case. Hæmothorax. Laceration of the lower lobes of the lungs.

Henry's case. Innumerable small subpleural hæmorrhages. Collapse of the right lung; partial collapse of the left lung; empyema right; multiple abscesses in both lungs. Thrombosis of the pulmonary artery.

Bolt's case. Congestion and œdema of the lungs.

Robertson's case. Subpleural and pericardial hæmorrhages. Hæmorrhagic consolidation of the lungs. Bronchopneumonia.

Ollivier's cases. Congestion of the lungs, subpleural and pericardial hæmorrhages. Hæmothorax and hæmorrhagic consolidation of the lungs in some cases.

Tardieu's cases. (Findings similar to Ollivier's, above.)

(d) *Abdomen.* The clinical findings in Pierce's and Hueter's and our own cases have been noted. Necropsy examinations have shown the following:

Braun's case. Hæmoperitoneum, hæmorrhagic infiltration of the omentum. Laceration of the liver, spleen, and left renal and suprarenal arteries. Herniation of left kidney into the thorax.

Milner's case. Hæmoperitoneum; laceration of the spleen, liver, kidney, and diaphragm. Perforation of the duodenum.

Bolt's case. Passive congestion of the abdominal viscera.

Lang's case. Rupture of the liver and spleen. Hæmoperitoneum.

3. THEORIES AS TO ITS CAUSATION

Satisfactory explanations of the various manifestations of this condition have naturally been sought by those interested in it. The immediate cause has in all cases been a violent compression of the thorax or upper abdomen or both. The characteristic discoloration of the skin of the face and neck has followed in a few minutes but occasionally has not reached its maximum until the day following the injury. Ollivier concluded simply that death in the 23 cases examined by him was due to asphyxia, the result of violent compression of the thorax. Tardieu does not comment upon the causation of the discoloration of the face. Hueter (1874) suggested two causes for the condition: (1) mechanical, due to back pressure of the blood with dilatation of the vessels of the face; and (2) nervous, due to injury of the sympathetic in the abdomen with a resultant paralysis of the vessel walls in the distribution of the cervical sympathetic. He (with Vogt) tried to reproduce the condition in animals, which will be commented upon later. Perthes was, so far as I can gather, the first to call attention to the absence of functionating valves in the veins of the head and neck as an explanation for the limitation of the area of discoloration. His explanation of the characteristic discoloration was, then, that the increased intrathoracic pressure, the result of the thoracic compression, was transmitted into the veins of head and neck which ruptured, with the extravasation of blood into the tissues.[1] This explanation was accepted for a time by subsequent writers, but the clinical observation that the discoloration during the period of its disappearance failed to show the chromatic changes characteristic of absorbing extravasations of blood, led Beach and Cobb and subsequent observers to

[1] Perthes states that the valves at the junction of the internal jugular and innominate veins (the only valves present in these veins) are incapable of resisting the back pressure of an injection mass starting at the vena cava.

examine sections of the skin removed from the discolored areas. As indicated above, the majority has failed to find an extravasation of blood into the skin, and, therefore, the more recent belief is that the discoloration is due to a venous stasis, the result of overdistention with, perhaps, paralysis of the walls of the veins. The matter, however, would not appear to be entirely settled. Bolt's and Robertson's findings in the skin excised from their cases (see pathological findings: *Tissues of Face and Neck*) are somewhat doubtful. Moreover, that extravasation of blood has occurred into the tissues of the face and neck without direct injury to these structures is clear from the autopsy reports. The observation of Robertson that the ecchymotic spots in the skin subsequently became a brownish-yellow suggests chromatic changes.[1]

The almost invariable association of subconjunctival hæmorrhage in this condition has been assumed to be the result of retrobulbar extravasations which have occurred in a number of cases at necropsy. Retrobulbar hæmorrhages have also been assumed to be the cause of the exophthalmos not uncommonly seen in this condition.

Intracranial and retinal hæmorrhages have been surprisingly infrequent. The only explanation thus far offered (suggested by Braun and Wesseley in the same year, 1904) is that the intracranial and intra-ocular pressures oppose the pressure in the vessels and so prevent their rupture. It was suggested by the clinical observation (made in 22 cases) that the characteristic discoloration of the face and neck stops exactly at and is absent under points of pressure such as the collar band, the hat band and the suspenders. It has been accepted by perhaps a majority of the writers on the subject; not accepted by others.

[1] Of interest in connection with the causation of the condition is the case reported by Kredel, Zentralbl. f. Chir., 1907, xxxiv, 1472. An infant only 17 hours old was operated upon for a large umbilical hernia containing the whole liver and the greater part of the intestines. Great pressure had to be exerted upon the liver to reduce it into the abdominal cavity and great force was necessary in order to close the abdomen. At the conclusion of the operation, to the surprise of the operator, the child's face showed a bluish discoloration and was marked by numerous petechial hæmorrhages. The right eye showed a subconjunctival hæmorrhage. Ophthalmoscopic examination failed to show any retinal hæmorrhages. Here, then, in the author's opinion is a physiological experiment, the condition of traumatic asphyxia having been produced by pressure upon the liver. He is of the opinion that the pressure upon the liver caused a great mass of blood to be forced to the right heart and that this pressure was communicated to the large veins of the face and neck.

4. EXPERIMENTAL DATA

The only experimental attempts to reproduce the condition which I have been able to find are those of Vogt and Perthes. Hueter in his paper comments upon the experiments of Vogt on rabbits. Compression of the abdomen, either sudden or continued, caused a dilatation of the ear veins, but no discoloration of the face. Division of the splanchnic nerves in the abdomen caused dilatation of the vessels of the skin but no discoloration of the face. Perthes produced energetic compression of the thorax in two white rabbits and found that there was a dilatation of the ear veins and cyanosis of the mouth and eyelids. He was unable to produce cyanosis of the face and explains his failure as due to the presence of valves in the veins which are capable of resisting pressure.

5. TREATMENT

Excepting a venesection performed upon his patient by Shimonek, there has been no treatment for the condition. The cases have died either immediately following the injury or later from some complication. Shimonek's patient was unconscious and respiration had ceased; the heart "was beating against the chest wall with great vigor pointing to the great obstruction against which it was laboring." Believing that the patient's right heart required immediate relief, he opened the median basilic vein. The blood "flowed in a large black stream" and by the time 1 quart of blood had escaped, respiration commenced and in a short time consciousness returned. The patient recovered.

6. MORTALITY

Of the 127 cases included in this report, 27 were dead as a result of their injuries or died a few moments after being seen. Of the 100 cases which survived the initial injury, 92 recovered and 8 died. Death in the majority of cases was due to extensive injuries of important organs or to infectious complications (pneumonia, empyema).

THE OCULAR AND VISUAL DISTURBANCES IN TRAUMATIC ASPHYXIA

The comment has frequently been made by writers upon traumatic asphyxia that visual

disturbances and retinal hæmorrhages have been rare complications of this condition. The complete loss of vision in our case seemed to us, therefore, a most unusual result and led us to look up the literature on the subject. As no mention was made in many of the collected cases of visual disturbances or ophthalmoscopic examinations, we have with two exceptions (Kossobudzki, quoted by Milner and Wienecke; Roset, quoted by Bolt), consulted the original articles. Including the cases of Ollivier and Tardieu, of Orth mentioned in the discussion of Borchardt's paper, of Edington mentioned in the discussion of Beatson's paper, and our own, there are 127 cases reported in the literature. Leber's 4 cases referred to by Wagenmann are the same as those reported by Voelcker, and are not included. Wesseley's 3 cases mentioned in the discussion of Borchardt's paper, presumably also are included in Voelcker's cases. Somerville's case mentioned in the discussion of Beatson's paper, appears to us atypical and is, therefore, not included. Of these 127 cases, the 23 cases of Ollivier, the case of Niemann, and one of Milner and Schultze, were dead when first examined, and the only notes referable to the eyes which were made are those regarding subconjunctival hæmorrhages and exophthalmos.

SUBJECTIVE VISUAL DISTURBANCES

The only mention of immediate subjective visual disturbances is found in the case reports of Perthes (2 cases), Neck, Braun (2), Scheer, Joynt, Moeser, Le Dentu, Bolt, Lang, Béal (2), Parker (also reported by Eliot), Anderwert and Heuer; 16 cases in all. Three other cases (Beatson, Pierce, and Kock and Roenne) had no immediate visual disturbances, but later complained of failing vision.

1. Perthes's case 1. M. 14. For an hour after regaining consciousness, the boy stated that he was unable to see. Vision later completely returned. No note that an ophthalmoscopic examination was made.

2. Perthes's case 2. M. 36. While being crushed he had the sensation that his eyes were "popping from his head." He stated that he became completely blind almost immediately. Subsequent complete return of vision. Retinæ normal on the eighth day after injury.

3. Neck's case. M. 38. Stated that for half an hour after the accident he was totally blind. Then vision returned in the right eye but failed to return in the left. Impairment of vision in the left eye permanent (visual acuity, 4/12). Ophthalmoscopic examination showed hæmorrhages in the macula of the left eye; right eye normal.

4. Braun's case 1. M. 45. Admitted 6 hours after injury complaining that he was completely blind. Died 30 hours after injury without return of vision. Ophthalmoscopic examination negative.

5. Braun's case 2. M. 27. Stated that during and immediately after injury he was unable to see. Later, on examination at the hospital, vision had returned. Author suggests that inability to see may have been due to swelling of lids. Ophthalmoscopic examination negative.

6. Scheer's case. M. 35. After recovering consciousness he noticed that vision in his left eye was markedly impaired. Four weeks later visual acuity, left = 5/30; 8 weeks later, visual acuity, left = 5/10; 3 months later, visual acuity, left = 5/5. Ophthalmoscopic examination showed two hæmorrhages in the left retina; right eye normal.

7. Joynt's case. M. 23. Stated that while being crushed he became completely blind and remained so until a few minutes after he was released. Dimness of vision disappeared at once in his left eye but continued for 24 hours in his right eye. Diplopia for 3 days. No note that an ophthalmoscopic examination was made.

8. Moeser's case. M. 50. On regaining consciousness he stated that he was absolutely blind. Impairment of vision permanent. Five weeks after injury, visual acuity, right = movements of hand at 1 meter; left = 6/35. Six months after injury, visual acuity, right = movements of hand in front of eyes; left = 5/25. Subsequently, right eye became completely blind; left remained 5/25. Numerous retinal hæmorrhages in right eye; one large hæmorrhage in left eye.

9. Le Dentu's case. One of his cases had visual disturbances, but the exact nature and degree are not stated. Ophthalmoscopic examination showed minute retinal hæmorrhages.

10. Bolt's case. M. 38. Stated that he was completely blind for 15 to 20 minutes after injury. Impairment of vision continued for some time, but normal vision was apparently recovered. Photophobia. No retinal hæmorrhages.

11. Heuer's case. M. 31. On opening eyes after accident complained of loss of vision. Three days after injury was able to recognize large moving objects and masses of color; unable to count fingers. Subsequent total blindness. Retinal hæmorrhages.

12. Lang's case. M. 42. Completely blind for 14 days after the accident, then a partial return of vision. At the time of the report the *left eye* had no perception of light, the optic disc was atrophic, the retinal vessels normal; the *right eye* showed 4/5 normal vision, the lower part of the disc was pale and the visual field contracted. The retinal vessels were

normal. There is no mention made of retinal hæmorrhages.

13. Béal's case 1. M. 49. Immediately after injury the patient complained of diminution in vision. Examined a couple of days after the injury he was unable to read the headlines of a journal at 20 centimeters. Opthalmoscopic examination showed attenuation of the arteries. Three weeks after the injury ophthalmoscopic examination showed in the *right eye* an oval macular hæmorrhage, some retinal œdema and attenuation of the arteries. The *left eye* was normal. Three months after injury vision in the *right eye* = counting fingers at one meter; in the *left eye* = 7 opts. There was a bilateral optic atrophy.

14. Béal's case 2. M. 14. The boy stated that for 2 hours after the accident the left eye was completely blind, then vision rapidly returned. There was impairment of vision in the right eye with dilatation of the pupil and loss of light reflex. Ophthalmoscopic examination 8 days after the injury showed *right eye*—disc normal in outline, arteries small, veins engorged and retina œdematous. The macular region showed a classical picture of thrombosis of the central artery with numerous small retinal hæmorrhages Visual field (5 centimeter disc) normal for white and colors. Visual acuity = counting fingers at 50 centimeters. *Left eye*—pupil and reflexes normal. Fundus normal. Visual acuity = 7/10 normal. Four months after injury right eye showed disappearance of the retinal hæmorrhages, diminution in the size of the arteries and marked optic atrophy. Visual acuity = less than 1/10 normal. Left eye—remained as at first examination above.

15. Parker's case (also reported by Eliot). M. 23. Immediately after the injury he had total loss of vision in his right eye. Examination showed right eye—no perception of light and sluggish papillary response. The optic disc was white with great engorgement of the veins and slight retinal œdema, apparently no retinal hæmorrhages. Left eye—vision normal, some engorgement of the veins and retinal œdema; otherwise negative. One month after injury, right eye—blind; no pupillary response, optic atrophy. Left eye—vision normal, fundus normal excepting for venous engorgement.

16. Anderwert's case. M. 26. Stated that for about 10 minutes after the injury he was totally blind. Vision promptly returned. The pupils reacted promptly. There are no notes to indicate that an ophthalmoscopic examination was made. Apparently there was not any disturbance in vision at the time of his discharge.

17. Kock and Roenne's case. M. 54. For 2 days after the injury there were no visual disturbances and ophthalmoscopic examination on the second day showed normal fundi. On the third day after injury the patient complained of "a cloud in front of his left eye" but he could see a candle flame and count fingers. On the fifth day after the injury the left eye was completely blind and showed a reactionless pupil; the right eye showed one-half normal vision; ophthalmoscopically both fundi were normal. The visual field of the right eye was normal. On the eighth day ophthalmoscopic examination showed the left fundus normal; the right fundus, however, showed a small fresh retinal hæmorrhage extending over the border of the disc which was not noticed at the previous examinations. Final examination: The left eye remained blind and there appeared a complete atrophy of the nerve head. The vision of the right eye improved and became five-sixths normal. The hæmorrhage disappeared.

18. Beatson's case. There was no complaint of disturbance in vision after the accident and ophthalmoscopic examination was negative for retinal hæmorrhages. The man was discharged apparently well. About 1 year after the injury the author received a letter from Dr. Ramsay, saying that the patient's eyes had become very much affected and that the ophthalmoscope showed distinct atrophy of both optic discs at their outer aspect, especially marked in the right eye. The visual fields were greatly contracted. Dr. Ramsay feared the loss of sight was progressive and that the patient would ultimately become blind.

19. Pierce's case. M. 21. There were no visual disturbances for some weeks after the accident. The pupils were equal and reacted normally. An ophthalmoscopic examination was not made. At the time of his discharge he complained of impairment in vision and his eyes were examined and fitted with glasses. The author presumes that retinal changes, the result of the accident, were responsible for the visual disturbances.

Of the cases reported in the literature (including our own) 16 are noted to have had immediate subjective visual disturbances. These have been indicated above. In 53 cases no mention is made of the presence or absence of visual disturbances; in 10 cases we can gather that there presumably were no visual disturbances, but the fact is not definitely stated; and in 21 cases it is definitely stated that there were no visual disturbances. In one case (Beatson's) in which presumably there were no immediate visual disturbances, and in two (Pierce's, and Kock and Roenne's) in which it is definitely stated that there were none, subsequent disturbances appeared. When we examine the cases with visual disturbances we find:

1. In 6 cases (Perthes, 2; Braun; Joynt; Bolt; and Anderwert) loss of vision was immediate but the return of vision was very rapid (within 24 hours). In 3 of these cases an ophthalmoscopic examination was made and reported negative for retinal hæmorrhages. In 3 cases there are no notes to indicate that

an ophthalmoscopic examination was made. Braun's first case also falls into this group, but he died before the outcome regarding his vision was known.

2. In 8 cases (Neck; Scheer; Moeser; Heuer; Lang; Béal, 2; Parker) loss or impairment of vision in one or both eyes was immediate, and in all except Scheer's case, permanent. In 4 cases impairment of vision involved but one eye, and in Scheer's case recovery was complete in 3 months. In 4 cases impairment of vision involved both eyes and was permanent. Moeser's, Lang's, and Parker's cases eventually became completely blind in one eye and had one-fifth, four-fifths, and five-fifths normal vision respectively in the other. Our case has remained blind in both eyes after 2½ years. In 6 of these 8 cases, ophthalmoscopic examination showed the presence of retinal hæmorrhages, in the majority about the macular region; in two (Lang, Parker) examination of the fundi apparently failed to show any retinal hæmorrhages.

3. In 3 cases (Pierce, Beatson, and Kock and Roenne) there was no immediate impairment or loss of vision, but subsequently impairment of vision was complained of. Pierce's patient complained of impaired vision at the time of his discharge from the hospital many weeks after his injury. Unfortunately, an ophthalmoscopic examination was not made; nor do we know the patient's subsequent history. The author assumes, in view of the fact that the patient had never previously had any visual disturbance, that impairment of vision was a result of retinal changes due to the accident. Beatson's patient had no immediate visual disturbances and ophthalmoscopic examination failed to show retinal hæmorrhages or other abnormalities. At least 16 months after the patient's injury, Beatson received a communication from Dr. Ramsay stating that the patient's sight had become very much affected, that ophthalmoscopic examination showed atrophy of both optic discs at their outer aspect, especially marked in the right eye, and that the visual fields showed great contraction. Kock and Roenne's patient complained of impairment of vision 3 days after his injury and subsequently became blind in his left eye but retained five-sixths normal vision in his right. An unusual finding was the absence of retinal hæmorrhages in the eye which became blind, the presence of a retinal hæmorrhage in the eye which recovered.

Although the number of cases from which to draw conclusions is small, it would appear:

a. That immediate loss of vision may occur in the absence of retinal hæmorrhages, but that the return of vision is rather prompt The explanation for the loss of vision is not clear. It has been suggested that venous engorgement with retinal œdema is the cause. An analogous disturbance is temporary loss of hearing with rather prompt recovery, as noted in Pichler's and Bolt's cases.

b. That permanent impairment or loss of vision has in the majority of instances been associated with retinal hæmorrhages. Beatson's, Lang's, Parker's, and Kock and Roenne's cases are, however, exceptions and indicate that permanent visual disturbances may occur in the absence of retinal hemorrhages.

c. *Subconjunctival hæmorrhages.* Marked subconjuctival hæmorrhages have been noted in practically all cases. Ollivier specifically states that they were present in only 9 of the 23 dead examined by him; but subsequent writers mention the condition almost without exception. As previously noted, it would appear to be from necropsy examination, the result of a retrobulbar extravasation.

d. *Exophthalmos* has been specifically noted in 27 cases; it has either not been present or is not specifically noted in 100 cases. In a few cases it is noted that it disappeared subsequently; in the majority of cases no mention is made of the outcome of the condition. Necropsy examination in 3 cases has shown the presence of fluid blood in the retrobulbar space or hæmorrhagic infiltration of the retrobulbar fat; findings which in the opinion of the majority are sufficient to explain the exophthalmos.

e. *Pupillary changes.* These are noted in 14 cases, are stated to have been absent in 10 cases, have either been absent or are not specifically noted in 103 cases. The pupillary changes which have been noted have not been constant. In 7 cases the pupils were wide and reactionless, but the patients were uncon-

scious when examined. In 2 cases the pupils were contracted and failed to react; in 1 case the pupils were unequal, the left being larger than the right, but both reacted to light. In 4 cases there was a unilateral dilatation with loss or impairment of the pupillary reaction associated with impairment of vision. The subsequent history as regards these pupillary changes is lacking in the majority of cases. In Braun's case the pupils remained dilated *ad maximum* after consciousness returned and continued so until death occurred 30 hours after the injury. In 1 of our cases the pupils, unequal when first examined, later became equal.

f. *Ocular palsies.* Ocular palsies have been noted in only 2 cases. In Braun's case there was apparently a complete ophthalmoplegia (paralysis of third, fourth, and sixth nerves), the patient being unable to move the globes in any direction. He died 30 hours after the injury. The necropsy examination fails to note any examination of the cranial nerves in an attempt to explain the condition. There was fluid blood in the retrobulbar space and hæmorrhagic infiltration of the retrobulbar fat; no intracranial hæmorrhage. In Joynt's case there was a diplopia (palsy of the sixth nerve?) which persisted for 3 days, then disappeared completely.

g. *Ophthalmoscopic examination.* Ophthalmoscopic examination is stated to have been made in 44 of the 127 cases; was either not made or not stated to have been made in 83 cases. In 11 of the 44 cases in which an examination was made, retinal hæmorrhages were present; an additional case in which the retinæ were examined after death showed retinal hæmorrhages. In the remaining 32 cases in which examination was made, the retinæ are stated to have been normal in 26 cases, and to have shown a hyperæmia, congestion, or œdema in 6 cases. In 8 cases in which retinal hæmorrhages were present, there were definite visual disturbances; in 3 cases there were no visual disturbances. Neither the presence nor absence of visual disturbances, therefore, guarantees the presence or absence of retinal hæmorrhages, and it is possible that more frequent examinations of the fundi in cases of traumatic asphyxia will show that retinal hæmorrhages in this condition are more common than has been supposed.

h. *Perimetric examinations.* Perimetric examinations are noted in only 7 cases. In 2, a central scotoma corresponding to a macular hæmorrhage was found; in 4, the visual fields were contracted in varying degree. In our case a series of examinations showed the gradual disappearance of a small area of retained vision until complete blindness supervened.

i. *Permanent visual disturbances.* As previously noted, 16 cases had immediate loss or impairment of vision following the injury. Six of these cases promptly recovered their vision, and one completely recovered his vision after 3 months. Seven cases had permanent impairment or complete loss of vision. One case died before vision returned and one case is so incompletely reported as to be valueless. In addition to these 16 cases are 3 which immediately after injury had no impairment of vision but which subsequently had impairment of vision. One of these is incompletely reported, and we can form no opinion of the extent of the visual impairment. Of the 127 cases reported in the literature, therefore, we know the outcome of the visual disturbances in 9. These are the cases of Neck, Moeser, Beatson, Lang, Kock and Roenne, Béal (2), Parker, and Heuer, and they may be summarized as follows:

Neck's case. Examination 2 months after injury. Visual acuity, right eye—normal. Visual acuity, left eye—1/3 normal.

Moeser's case. Examination more than 6 months after injury. Visual acuity, right eye—0. Visual acuity, left eye—1/5 normal.

Beatson's case. Examination 16 months after injury. "Vision markedly impaired. Feared patient would become blind."

Lang's case. At last examination (time indefinite). Visual acuity, right eye—4/5 normal. Visual acuity, left eye—0.

Kock and Roenne's case. At last examination (time indefinite). Visual acuity, right eye—5/6 normal. Visual acuity, left eye—0.

Béal's case. 1. Examination 3 months after injury. Visual acuity, right eye—ability to count fingers at 1 meter. Visual acuity, left eye—7 opts.

Béal's case. 2. Examination 4 months after injury. Visual acuity, right eye—1/10 normal. Visual acuity, left eye—7/10 normal.

Parker's case. Examination 1 month after injury. Visual acuity, right eye—0. Visual acuity, left eye—normal.

Heuer's case. Examination 2½ years after injury. Completely blind.

Loss or impairment of vision in these cases has been associated with a progressive optic atrophy. In 5 of the cases, loss or impairment of vision may be explained by the retinal hæmorrhages. In Beatson's, Kock and Roenne's, Parker's, and Lang's cases, some other explanation must be sought; and the only one thus far offered is that it is due to degenerative changes in the retina, the result of vascular stasis with œdema.

ADDENDUM. Since writing the above article another case of traumatic asphyxia has been reported by Thomas M. Green, Surg., Gynec. & Obst., 1922, xxxv, 129. This case is unique in that it is the first instance of the condition recorded in deep sea divers. There are no notes in this report regarding visual disturbances; nor is it recorded that an ophthalmoscopic examination was made.

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PRELIMINARY PNEUMOTHORAX IN LUNG SURGERY[1]

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IN this paper I will discuss the possibility of performing pulmonary operations by means of thoracotomy with pleura free from adhesions and without fear of a pneumothorax. I will not refer to the experience of others except those of our great surgeon, Posadas (prematurely deceased 20 years ago), who, as far back as 1896, operated for hydatid cyst and avoided pneumothorax and its terrible consequences by "harpooning," that is, by drawing the lung close to the wound thus, so to speak, shutting the pleural wound, and then performing the operation.

The spectacle following this operation was most striking because there was a sudden change in the physiological condition of the lungs and pleura; undoubtedly, the patients suffered to some extent as a result. General anæsthesia was used, as a rule, and I think more than once helped to aggravate the condition.

After Posadas' work, little or nothing was accomplished in Argentine in improving the technique for pulmonary operations, although such operations were frequently done because of the prevalence in our country of hydatids of the lung.

At the Institute of Surgery, about 3 years ago, we began using a new technique, to which, and not to a fortunate series of cases, I believe we may attribute the good results and the ease with which we have been able to carry out some pulmonary operations with the pleura free from adhesions and in the presence of a large thoracotomy.

We proceed in the following manner: When a diagnosis of pulmonary affection requiring surgical intervention (most frequently a hydatid cyst) is made, we take a roentgenogram of the thorax and introduce into the pleura of the side affected, a quantity of oxygen, or preferably nitrogen, varying from 300 to 500 cubic centimeters. For this purpose we use one of the types of apparatus employed for the production of artificial pneumothorax in the treatment of pulmonary tuberculosis. Besides those instruments universally known, there are two or three excellent models in Argentine. For a trocar we use an ordinary hollow platinum needle, or that of one of our colleagues—Dr. Zorraquin—with which pleural puncture can be done without the danger of wounding the lung. Two or three days after the first injection a second one of 700 cubic centimeters is given; and 2 or 3 days later one of 1,000 cubic centimeters.

In making this pleural puncture, difficulties may be encountered that indicate the existence of pleural adhesions. If adhesions are found, puncture should be carried out in another region, and the search should be continued until a satisfactory result is obtained, unless one is convinced that the pleural adhesions are so diffuse as to make it impossible to produce an artificial pneumothorax. It goes without saying that in the presence of pleural syntexis or extensive adhesions, intrapulmonary operations can be carried out without the fear of an operative pneumothorax resulting. Otherwise, it follows that the patients who have received the dose of gas above referred to, when examined under roentgenoscopic screen, are found to show no pneumothorax of importance. In such cases, several further punctures may be undertaken, bearing in mind always the susceptibility or individual reaction of each patient.

Generally three punctures are sufficient, and when finished, another roentgenogram is taken which permits of the comparison of the conditions, before and after the formation of the pneumothorax. In this condition the patient is prepared for operation.

The technique of operation is briefly this:

Local anæsthesia (with a freshly made solution of novocaine, one-half of 1 per cent) is the method of choice. It is well to infiltrate an area larger than that intended for the surgical work to assure operating always in tissues totally anæsthetized.

[1] Presented before the Physicians' Club of Chicago, November 4, 1922.

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PRELIMINARY PNEUMOTHORAX IN LUNG SURGERY[1]

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IN this paper I will discuss the possibility of performing pulmonary operations by means of thoracotomy with pleura free from adhesions and without fear of a pneumothorax. I will not refer to the experience of others except those of our great surgeon, Posadas (prematurely deceased 20 years ago), who, as far back as 1896, operated for hydatid cyst and avoided pneumothorax and its terrible consequences by "harpooning," that is, by drawing the lung close to the wound thus, so to speak, shutting the pleural wound, and then performing the operation.

The spectacle following this operation was most striking because there was a sudden change in the physiological condition of the lungs and pleura; undoubtedly, the patients suffered to some extent as a result. General anæsthesia was used, as a rule, and I think more than once helped to aggravate the condition.

After Posadas' work, little or nothing was accomplished in Argentine in improving the technique for pulmonary operations, although such operations were frequently done because of the prevalence in our country of hydatids of the lung.

At the Institute of Surgery, about 3 years ago, we began using a new technique, to which, and not to a fortunate series of cases, I believe we may attribute the good results and the ease with which we have been able to carry out some pulmonary operations with the pleura free from adhesions and in the presence of a large thoracotomy.

We proceed in the following manner: When a diagnosis of pulmonary affection requiring surgical intervention (most frequently a hydatid cyst) is made, we take a roentgenogram of the thorax and introduce into the pleura of the side affected, a quantity of oxygen, or preferably nitrogen, varying from 300 to 500 cubic centimeters. For this purpose we use one of the types of apparatus employed for the production of artificial pneumothorax in the treatment of pulmonary tuberculosis. Besides those instruments universally known, there are two or three excellent models in Argentine. For a trocar we use an ordinary hollow platinum needle, or that of one of our colleagues—Dr. Zorraquin—with which pleural puncture can be done without the danger of wounding the lung. Two or three days after the first injection a second one of 700 cubic centimeters is given; and 2 or 3 days later one of 1,000 cubic centimeters.

In making this pleural puncture, difficulties may be encountered that indicate the existence of pleural adhesions. If adhesions are found, puncture should be carried out in another region, and the search should be continued until a satisfactory result is obtained, unless one is convinced that the pleural adhesions are so diffuse as to make it impossible to produce an artificial pneumothorax. It goes without saying that in the presence of pleural syntexis or extensive adhesions, intrapulmonary operations can be carried out without the fear of an operative pneumothorax resulting. Otherwise, it follows that the patients who have received the dose of gas above referred to, when examined under roentgenoscopic screen, are found to show no pneumothorax of importance. In such cases, several further punctures may be undertaken, bearing in mind always the susceptibility or individual reaction of each patient.

Generally three punctures are sufficient, and when finished, another roentgenogram is taken which permits of the comparison of the conditions, before and after the formation of the pneumothorax. In this condition the patient is prepared for operation.

The technique of operation is briefly this:

Local anæsthesia (with a freshly made solution of novocaine, one-half of 1 per cent) is the method of choice. It is well to infiltrate an area larger than that intended for the surgical work to assure operating always in tissues totally anæsthetized.

[1] Presented before the Physicians' Club of Chicago, November 4, 1922.

Thoracotomy, simple, with a single rib, or thoracotomy with flap of Posadas which takes in two ribs. Although the physical and roentgenological signs permit the exact localization of the pulmonary lesion with the patient in upright position, we usually prefer the Posadas flap, because the pneumothorax and the reclining position of the patient during operation change slightly the relation of the lesion in the lung to the wound of the thorax.

The flap of Posadas is U-shaped, with the opening of the U backward, and its parallel sides running in the intercostal spaces, close along the edges of the two ribs included in the operation.

The elevation of the musculocutaneous flap brings into view a large surface of the parietal pleura, corresponding to the width of the two ribs and of the three intercostal spaces adjoining. The pleura is incised in the form of the U, and although incision is made briskly, we find that the air does not enter with violence and that the usual phenomena of pneumothorax do not follow.

When necessary, the hand can be introduced through the wide thoracic opening to explore the lung and the pleural cavity. The lung is generally found retracted around the area containing the lesion.

The lung is drawn forward into the wound and, with the pleural cavity well protected, the necessary surgical work is done. If a hydatid cyst is present, it is incised and evacuated or aspirated, and the cavity at once cleansed—a manœuvre that always provokes some cough and difficulty in respiration. The pulmonary wound is then sewed up leaving the lung there. If it is necessary to drain, the lung is fixed to the parietal pleura.

If blood or other extraneous fluid is present, the pleural cavity is carefully cleansed and the pleural wound closed. It is generally not possible to obtain perfect approximation of the pleura, because of the retraction of the pleural flap; but this inconvenience is not of great importance.

The musculocutaneous flap is replaced, the muscular layer being sutured with catgut, and the cutaneous wound with silkworm gut. The patient is kept in bed in sitting posture. Eight days after operation, the sutures are removed from the cutaneous wound, and a new roentgenogram is taken.

In case pleural exudate forms, there is no need for haste in extracting it, even should there be a slight temperature, for it is generally absorbed. The patient must be carefully observed after operation and examined every second day with the roentgenoscopic screen.

The object of preliminary artificial pneumothorax is to produce retraction and disuse of the affected lung, thus making it necessary for the healthy lung to carry on the entire function of respiration. At the same time the pleura becomes accustomed to contact with an extraneous gas, and, when the parietal pleura is opened, contact with the exterior ambient medium does not affect it as it would otherwise.

Preliminary artificial pneumothorax causes retraction of the lung tissue around the lesion and in this way facilitates exploration, for when once the pleural cavity is opened the lesion presents itself immediately to view and is in ready access to the surgeon.

Experience has shown that, in operations on a lung free from pleural adhesions, a slow opening so that the pneumothorax may form little by little prevents the inconveniences produced by a sudden pneumothorax, at least to the extent that such inconveniences are not disagreeable.

Our experience with preliminary artificial pneumothorax produced by our method has been very encouraging. While, at present, we have performed only a small number of these operations, we feel very well satisfied with the results, and naturally we shall increase our experience with it as circumstances permit.

CONGENITAL HYPERTROPHY

Report of a Case with Diffuse Neurofibromatosis

By WILLIS C. CAMPBELL, M.D., M.A., F.A.C.S., Memphis, Tennessee

CONGENITAL hypertrophy is by no means an extremely rare affliction, but the unusual pathology in the case under consideration warrants a brief discussion of the subject.

Broca, in 1859, was probably the first to report the condition; since then there have been numerous cases in literature. Autopsies by McGregor, Arnheim, Wagner, and others offer no suggestion as to a possible cause. Gardiner collected 28 cases with 6 autopsies. E. G. Hall, in the *British Medical Journal*, reports a case associated with telangiectatic spots on the entire body. Finlaysin, in 1884, describes a similar condition with patches of cutaneous congestion. Kirvall operated on one case and found mainly fatty tissue. Ballance, in 1890, and Corbin, in 1920, respectively, report cases with deficient mentality. McGregor's case showed at times vasomotor disturbances. In Morbins' case there was a tenderness over hypertrophied extremities, for which reason he considers the condition a morbid entity. No operations were performed or sections made. Redard could find only the fatty tissue involved and attributed the condition to a change in the lymphatic system. Jordan distinguishes two types of elephantiasis, one a diffuse neurofibromatosis involving the nerves; the other, cutaneous structures and muscle tissue. He believes that the blood vessels give origin to the new tissue.

About 70 cases of various types of congenital hypertrophy have been reported in the literature to date but none exactly resembles the case under discussion.

Congenital hypertrophy may be confined to one side, one extremity, one or more fingers or toes—unilateral or bilateral. The fatty tissue predominates, and may be of an embryological type. In our case the condition was not apparent until one and one-half years of age, but from the slow onset, and the early age, we regard the condition congenital. However, from a pathological standpoint, it does not resemble any case of congenital hypertrophy which we could find hitherto reported.

From a clinical standpoint we thought that the origin was probably lymphatic, but as the preponderance of evidence from four of the most eminent authorities in this country consider the tissue a type of neurofibroma, we naturally concur.

Report of the case is as follows:

A. L. E., white girl, 14, admitted to the Crippled Children's Hospital-School, February 21, 1920. Family and past history uneventful; normal labor; walked at age of 1 year; no abnormality until 1½ years of age, when mother noticed right ankle and foot larger than left. Shortly thereafter enlargement of the entire extremity was apparent. This relative difference in length and circumference increased until present condition existed.

Physical examination revealed a healthy girl of 14, with no abnormalities bearing on the subject in question, except the lower extremities. The left lower extremity was normal; the right showed marked hypertrophy in circumference and length with distortion of knee and ankle. The patient walked with great difficulty, using the hand on the right knee, which was in valgus with external rotation of leg; weight was borne on the dorsum of a club foot (equinus varus third degree). The skin was soft and flabby, otherwise normal. The entire extremity beneath the deep fascia was infiltrated with a diffuse, lobulated tumor, which could not be differentiated from the muscles. There were lobules and cylindrical masses, 1 to 2 inches in diameter, and of indefinite length. There was greater hypertrophy on the posterior aspect of the upper two-thirds of the thigh and calf. On deep pressure there was distinct tenderness over the entire extremity but accentuated over the posterior thigh and calf.

Measurements. Circumference of left thigh, 12 inches; right thigh, 16 inches; left calf, 9 inches; right calf, 12 inches. Length of lower left extremity, 30 inches. Length of lower right extremity, 35½ inches. (From anterior superior spine of ilium to tip of inner malleolus.)

Muscle power was diminished, which can be expressed by considering as normal ++++. Hip: flexors ++; adductors ++; abductors +; internal rotators +; external rotators ++. Knee: extensors +; flexors ++ (genu valgum). Ankle: dorsi flexors +; plantar flexors +; abductors +; tibials (equino varus). Blood count and hæmoglobin normal. Wassermann negative; urine negative.

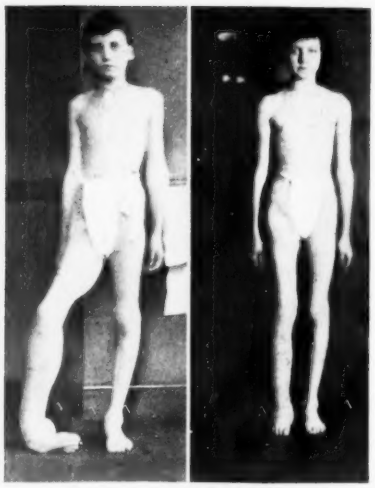

Fig. 1. Fig. 2.

Fig. 1 (at left). Before operation.
Fig. 2. After operation.

Roentgenograms of bones of left lower extremity normal; right lower extremity showed increase in length, decrease in diameter, structural atrophy.

A diagnosis of elephantiasis had been previously made and on account of the almost useless condition, amputation advised. In this we could not concur, though we believed the origin lymphatic, but the skin and superficial fat were apparently normal and the entire distribution of the tumorous tissue was beneath the deep fascia and intramuscular.

We also considered the possibility of an arterial or venous angioma, so decided to remove a section for examination. The patient was sent to the Baptist Hospital and a small incision was made over the dorsum of the foot. The skin and subcutaneous fat were normal as was the deep fascia. Beneath the fascia we found lobulated, yellowish masses intermingled with the tendons and somewhat more dense than fat. A liberal portion was excised, no undue hæmorrhage was encountered, and the wound was closed in routine manner. Laboratory reported embryonic lipoma and connective tissue. Two weeks later a more extensive procedure was undertaken, making an incision on the posterior aspect of the leg from the knee to the ball of the foot (using tourniquet). The skin, superficial and deep fascia was normal, below which was found long cylindrical masses, rather firm, 1 to 1.5 inches in diameter and extending for 10 or more inches. One continued into the thigh, through the popliteal space. These terminated in dense cords, which divided in an aborescent manner. Numerous cysts, with serous fluid, were disseminated throughout. There were also many associated irregular lobules closely resembling fat; at certain points we thought that these cylindrical masses were developed from the tendon sheaths, though their origin was by no means definite. The tumor tissue was diffused through the muscles, adherent, and in places spread out over the muscles so that it was impossible to excise *in toto* without destroying muscle tissue. At least one quart of this material was removed at the second operation, and equally as much at two subsequent procedures on the thigh. Healing after each was primary when we decided to attack the skeletal system. As the right femur was 4 inches longer than the left, we did a plastic shortening, though we were in doubt as to

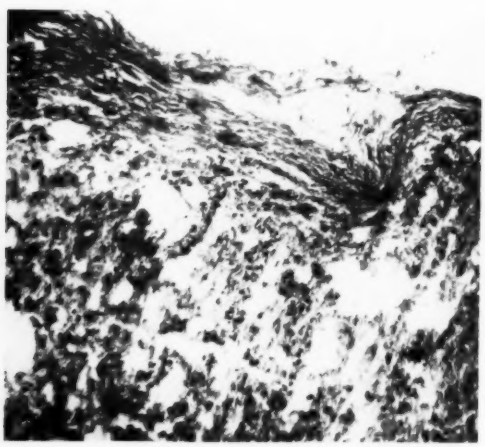

Fig. 3. Section 1. Low power photomicrograph showing the general loose arrangement of the cells in the tumor and the definite encapsulation.

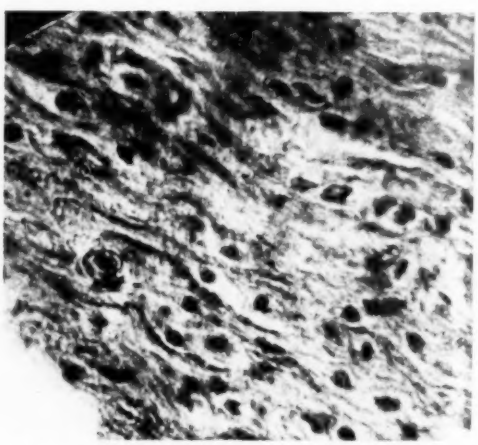

Fig. 4. Section 2. High power photomicrograph showing the large amount of poorly demarcated intracellular material with sparsely placed, regular nuclei.

the affect of such an extensive removal of bone continuity on the already depleted muscular apparatus. The following technique was employed at the Baptist Memorial Hospital, November 6, 1920:

After applying tourniquet, an incision of 10 inches in length was made over the lower two-thirds of the external aspect of thigh, through skin, superficial fat, fascia, and muscle to bone, exposing about 8 inches of the femur. With a motor saw the bone was severed transversely 4 inches above knee joint. In the same manner the anterior half of the shaft, in the upper fragment, was removed for 3 inches, then the posterior half of the lower fragment for 3 inches; 1¼ inch of each fragment was then removed and the extremity of each fragment trimmed to a sharp point, after which the upper and lower fragments were placed together, the upper extremity of the lower fragment extending into the marrow cavity above and the lower extremity of the upper fragment into the spongy bone of the lower fragment. With the drill, holes were made through both fragments and small bone pegs from the redundant bone inserted. After this the limb was unusually firm. The wound was closed in layers with routine dressings and plaster cast. Recovery was uneventful. In 6 weeks solid bony union had occurred. It was thought that further reduction in length could be accomplished through operative correction of the equino varus. Consequently, on March 2, 1921, the patient was returned from the Crippled Children's Hospital to the Baptist Memorial Hospital. An incision was made over the antero-external aspect of the ankle just internal to the fibula and extending to the middle of the cuboid bone (my usual incision for astragulectomy). This passed through the fascia to the ankle joint, just external to the extensor longus digitorum tendons giving excellent exposure to the astragulus when the foot was held in equinus. The astragulus was dissected loose from attachments and removed. The lower 1 inch of both bones of the leg was amputated with saw; a new ankle joint was then constructed with sharp chisel, reproducing both malleoli. A tarsectomy with removal of the articular surface of the pockets was made on either side of the calceneum, near the anterior extremity, for the reception of the malleoli. The foot was dislocated backward and parts approximated. Stitches of No. 2 chromic catgut were placed through the external malleolus and scaphoid, calcaneus and cuboid. The wounds were closed in routine manner with foot placed at right angles to leg. In other words, a modification of "Whitman's astragulectomy." The removal of the astragulus and lower 1 inch of both bones of the leg restored relative length desired. A plaster cast was worn for 8 weeks, when the foot was found to be in excellent position and perfectly stable. A destruction of the lower epiphysis in the leg was permissible as there was excessive growth at other points in the extremity.

At present after four operations on the soft parts and two on the skeleton, the measurements are as follows:

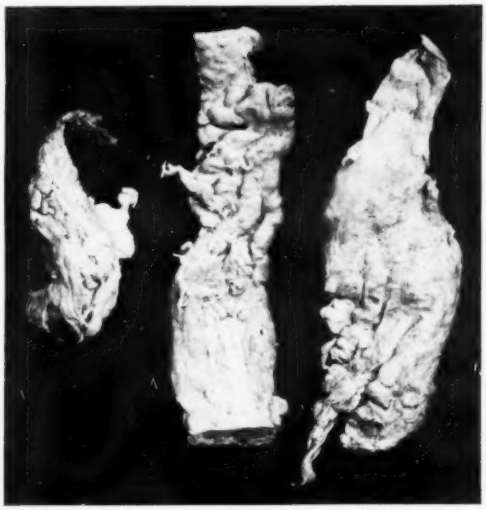

Fig. 5. Gross specimen showing the cords of tumor tissue tapering off into aborescent branches at the ends. The cord from which this specimen was taken was over 3 feet in length, extending from the ankle to the upper thigh, and clearly following the course of the sciatic nerve and its branches.

Circumference: right thigh, 14¾; left thigh, 13¾; right leg, 10¾; left leg, 9¾. Right anterior superior spine to tip of inner malleolus, 32 inches; left anterior superior spine to tip of inner malleolus, 32 inches. (Both limbs same length.)

The correction of deformity and removal of excess weight has materially enhanced the functional efficiency of the limb, especially knee action. The stability of the foot, with properly distributed weight-bearing is an obvious asset. There is some laxness in the knee joint but sufficient stability to walk with only a slight limp, which should materially improve in time. A simple knee brace has been employed to the present time, although she is able to walk without support. The apparatus should be discarded in a few months.

About 3 years have elapsed since the first operation and there is no sign of recurrence.

Pathological report. The tumor lay entirely below the deep fascia of the thigh and leg, apparently arising from the lymphatic channels running along the large vessels and nerves and in the fibrous intramuscular septa. It was arranged in cord-like manner, ½ to 3 centimeters in diameter. In many places it grew down a muscle bundle, such as the posterior tibial, almost completely replacing the muscle, causing a disappearance of the muscle fibers, not by invasion but by pressure atrophy. The tumor was encapsulated, at no place breaking through the capsule and invading the surrounding tissue. The cords of tumor tissue extended from the upper thigh

to the foot, a distance of about 3 feet. On section it was pale, translucent, not friable, with very few blood vessels, and each lobule was surrounded by a fibrous capsule.

The tissue took the routine hæmatoxalin and eosin very poorly.

Microscopical sections showed a loosely connected tissue composed of fibrous strands and rather sparsely placed nuclei, varying in size from small, round nuclei to moderate sized, oval and spindle shaped. The cell outlines were very indistinct and the cytoplasm stained very faintly. Between the cells and fibrous frame work was a hæmogenous material, apparently coagulated lymph, resembling a chronic œdema. There were no lymph spaces or channels. The chromatin was normal in amount, regularly arranged, and there were no mitotic figures. Each field contained one or more small round cells with eosinophile staining granules, and a small eccentrically placed nucleus, size and shape much like a plasma cell. The tumor had not broken through its capsule at any point.

In the fibrous septa between the main tumor lobules, were small strands of tissue the structure of which resembled that of a nerve and in which one pathologist states that he identified nerve tissue. This further suggests that the tumor was of perineural origin. Sections of the bone removed at operation showed atrophic changes, otherwise normal.

In conclusion I desire to express my appreciation to Col. George R. Callendar, Curator of the U. S. A. Medical Museum, and to Major James F. Coupal, Acting Curator, for their co-operation in the preparation of this paper and to Doctor Frank B. Mallory, of Boston, Dr. Albert C. Broders, of Rochester, Minnesota, Dr. James Ewing, of New York, Dr. Joseph C. Bloodgood, of Baltimore, and Dr. N. E. Leake, of Memphis, for the examination of the tissue.

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BILHARZIAL APPENDICITIS[1]

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AND
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INFECTIONS of man with the trematode parasite schistosoma are very common in certain parts of the world but even in these localities cases in which the symptoms are confined to the vermiform appendix would seem to be of extreme rarity.

There are believed to be two distinct varieties of schistosoma (1): schistosoma hæmatobium, described by Bilharz in 1852, the more common of the two, found chiefly in Africa, but also in Persia, Arabia, India, Panama, Cuba, and Porto Rico; and schistosoma japonicum, found in Japan, China, and the Philippines.

The commonest sites (2) of infection are the bladder and urethra, rectum, vulva, and vagina. Urinary symptoms, especially hæmaturia are the most common. The bladder lesions consist of patches of hyperæmia which later develop a "sandy" appearance due to the presence of enormous numbers of ova. Chronic inflammation develops with the formation of connective tissue, and this condition may lead to ulceration, phosphatic deposits, and stone formation.

Another type of lesion is hyperplasia affecting the mucosa with the formation of papillomata, in which malignancy may develop. Fistulæ, starting from the neck of the bladder or membranous portion of the urethra, are not uncommon. These arise in a mass of chronic inflammatory granulation tissue which contains large numbers of ova. Similar granulation-tissue tumors may arise in the region of the external genitalia, or in the groins.

Infection of the rectum produces symptoms of dysentery, with mucous and bloody discharges. Here too the lesions are chronic inflammatory with the formation of a mass of vascular connective tissue accompanied by ulceration, and also hyperplasia affecting the mucosa with the production of adenomatous polyps. Ova are abundant in the mucosa and submucosa. Most frequently the rectum only is involved, but in severe cases the entire large, and even the small, intestine may be affected.

Bilharzia infections are much rarer in the female than the male. Burfield (3) quotes the proportion of male to female infections as 24 to 1. In women as in men the most frequent symptom is hæmaturia, but there is often an acute vaginitis with or without involvement of the vulva where condylomata may be found. Horwood (4) describes the formation of a polypoid tumor of the cervix containing large numbers of ova.

Just how this parasite invades the human body is not known but it is presumably by way of the mouth, or through the mucous membrane of the urethra, vagina, or rectum, or possibly through the skin by means of contaminated water used for drinking or bathing. The ova, discharged in urine or fæces, quickly burst, when these discharges are diluted with water, and a motile ciliated embryo is extruded. It is presumably this form of the parasite which invades the tissues. It is argued that infection by mouth is improbable because these embryos seem not to survive an acidity equal to that of the gastric juice. Adult, sexually active forms are found only in the portal system. Worms in copula have been found in cases of rectal infection in the hæmorrhoidal veins, with large numbers of eggs in the surrounding rectal tissues. Similarly worms have been found in the vesicoprostatic plexus with eggs in the bladder mucosa. Postmortem, large numbers of eggs are commonly found in the liver. It is assumed that early development takes place in the liver and that the worms travel against the portal stream to its tributaries about the rectum, bladder, or elsewhere, and that eggs are here laid and are either carried back to the liver by the blood stream or are distributed

[1] From the Clinic of Woman's Hospital, New York.

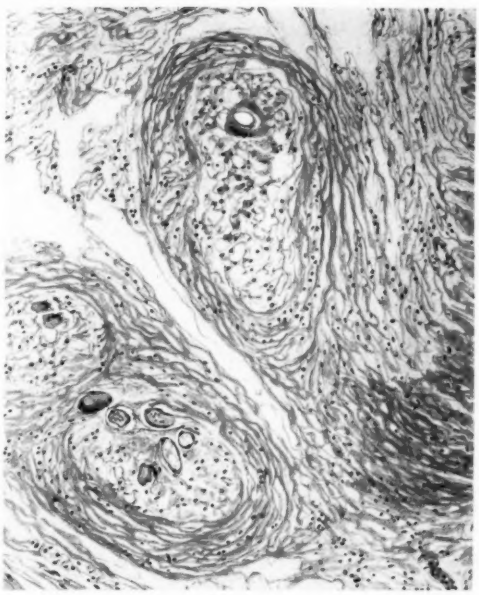

Fig. 1. Shows three tubercle-like nodules in the mesoappendix. In the upper is an empty shell enveloped by a giant cell. In the lower left are seen two giant cells only. In the lower right are six ova, the one farthest to the left being partially enveloped by a giant cell. (Drawing by Alfred Feinberg.)

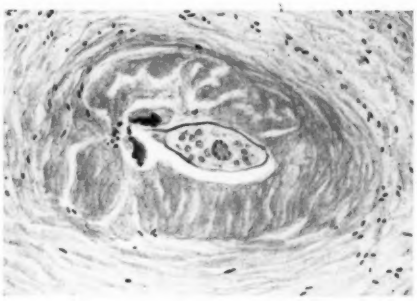

Fig. 2. Shows a very fibrous nodule in the center of which is a single ovum showing what is apparently a polar spine with a giant cell on either side. (Drawing by Alfred Feinberg.)

locally. Possibly there is a greater disposition to the latter when the vein is completely blocked, as it apparently often is, by the worms and the endarteritis produced by them. The possibility is not to be dismissed, however, that the embryos reach their sexually mature form in the small vessels at, or near, the site of invasion and there produce their eggs which are distributed locally and to the liver.

The writers have been able to find but two reported cases in which symptoms of bilharzia infection were confined to the appendix. One, by Burfield (3), was a male, 36 years old, who came from South Africa in 1905 for the treatment of a sinus of 18 months' duration in the right gluteal region. In 1899 he had had a slight attack of appendicitis. In 1902 a swelling appeared in the right iliac region which, a few months later, pointed in the right lumbar region, was incised and drained for a long time. In 1904 an abscess appeared in the right gluteal region. The appendix region was explored and a retroperitoneal abscess found which was drained posteriorly and was still discharging when seen by Burfield in 1905. Burfield operated and found the distal portion of the appendix sloughed. The proximal portion he removed. Sections showed abundant ova in the submucosa and the lesions found, according to his pathological description, correspond almost exactly to those in the appendix to be described. The patient had no symptoms of genito-urinary or rectal involvement and Burfield believes that the case was primarily an ordinary acute appendicitis with abscess formation, and that infection with schistosoma occurred only secondarily through the resulting sinus. In the light of the chronic history and with the knowledge from the case here reported that schistosoma can produce an appendicitis without clinically evident lesions elsewhere, it seems more probable to the writers that the primary lesion was produced by schistosoma.

The other case is one reported by Kelly (5). He says: "Aireton relates a case of bilharzia disease in which eggs of the parasite were lodged exclusively in the appendix." There is no further description of the case and no reference.

The writers have seen sections of one appendix, other than that here reported, which was infected with schistosoma. These slides are in the collection of the department of pathology in the College of Physicians and Surgeons, New York, and are from a young Chinese autopsied in Singapore by Dr. W. G. MacCallum. The writer is indebted to Dr. Mac-

Callum for examining some of the slides from the case here reported and for an account of his own case. Briefly, the man suspected of beriberi was infected with ascaris, ankylostoma, and schistosoma japonicum. The spleen and liver were both enlarged, the latter containing large numbers of schistosoma eggs. The stomach, duodenum, pancreas, and adrenals were normal. The upper ileum contained ascaris and ankylostoma. In the colon were yellowish patches which showed thousands of schistosoma eggs. The bladder was normal. Dr. MacCallum (6) says: "The liver, colon, and mesenteric glands show abundant eggs surrounded often by giant cells and tubercle-like capsules. These eggs are about the same size of those in your specimen. I can see no spines, but in sections with shrunken eggs that would be very difficult to be sure of anyway. The lesion is almost exactly the same as my sections show, apparently though it should be the African form and not the Eastern one."

Mrs. W. J. M., age 25, married 1 year, born in Scotland; *lived in South Africa* until 15. Measles lightly at 4; scarlet fever and diphtheria, mild attacks, at 18. Usually well and vigorous but always somewhat underweight. Moderate constipation, about 5 years, necessitating daily laxatives. Nothing abnormal ever noted in appearance of stools. Menses began at 12, epochs every 21 to 28 days, scanty, lasting but 2 days and with great pain first day. No contraceptive measures taken but never pregnant. Slight mucoid leucorrhœa several years.

Chief complaints: (1) sterility, (2) dysmenorrhœa, (3) frequent dull pains in right lower quadrant of abdomen for nearly 2 years. These pains are localized, bear no relation to urination, menstruation, or digestion, and are not influenced by exercise.

General physical examination revealed nothing abnormal. Abdomen thin and slightly retracted. Right kidney just palpable, felt normal. Slight tenderness on deep palpation over cæcum but no abnormality felt.

Pelvic examination discovered a uterus, two-thirds normal size, anteflexed, retrocessed, mobile, with small cervix and tiny external os. Appendages normal.

Urinalysis: A specific gravity, 1025; acid, no albumin or sugar, no formed elements in sediment. Wassermann negative. Blood: reds, 4,256,000; hæmoglobin, 90 per cent; leucocytes, 8,050; polymorphonuclears, 62 per cent; lymphocytes, 38 per cent.

Pre-operative diagnosis: Undeveloped uterus, anteflexed, retrocessed with stenosis of cervix. Chronic appendicitis.

Operation Woman's Hospital, by Dr. Bullard, February 26, 1921: Dilatation of cervix and insertion of stem pessary; appendectomy; Simpson technique of shortening round ligaments. Tubes and ovaries normal. Uterus normal but small, retrocessed, and very mobile. Gall bladder and kidneys felt normal, and all other structures seen or felt seemed to be normal. The appendix was about 2 inches long and of average diameter. There were no adhesions anywhere about. The entire mesoappendix and the distal two-thirds of the appendix were thickly studded with tiny grayish-white nodules resembling tubercles. The appearance was of a chronic lesion. The cæcum was not involved and careful inspection of intestines, omentum, and pelvic organs failed to find any more such lesions. There was an uneventful convalescence.

Two months later the stem pessary was removed. Pelvic examination found uterus in normal position and adnexa normal. No tenderness over cæcum. No abdominal pain or dysmenorrhœa since operation.

Pathological report. The specimen is an appendix 55 millimeter long by 7 millimeter in diameter with an attached thick mesoappendix. The lower half of the appendix and especially the mesoappendix show on the surface numerous small nodules up to 1 millimeter, or slightly more, in diameter. These resemble tubercles but are more glistening, and translucent than are conglomerate tubercles apt to be when they have reached the size of these lesions. On gross section, except for moderate apparent fibrosis, there are no definite lesions. The lumen is empty.

Microscopical. Sections show very numerous nodular lesions about the size of and very similar in appearance to tubercles. None of these is seen in the mucosa, there is a moderate number in the submucosa, and none in the muscular layers, but in the serosa and throughout the entire thickness of the mesoappendix, especially close to the appendix, they are extremely numerous. In these nodules are seen sometimes one ovum, sometimes six or more, with a very definite cell membrane. Sometimes they are of fairly regular oval form but more often partially collapsed. The shell may be empty, filled with granular material, or contain numerous very small, round, hæmatoxylin-staining bodies, resembling nuclei. Some ova are calcified. By the search of serial sections two ova were found which possessed what was apparently a spine, in both cases terminal. One of these ova is shown in Figure 2. Frequently one or more giant cells with many nuclei lie adjacent to, or apparently completely envelope, an ovum. Rarely an ovum is seen lying in the tissue with practically no surrounding tissue reaction but nearly always the tubercle-like nodule is seen consisting of large mononuclear cells, with an occasional giant cell, immediately surrounding the ovum and outside of this a fibrous capsule. In what are presumably the older lesions, dense fibrous tissue immediately surrounds the ovum with very few cells of any kind. In large areas of the mesoappendix, the tissue between the nodules is densely infiltrated with neutrophile

and eosinophile polymorphonuclear leucocytes, but no tissue necrosis is seen anywhere.

When the diagnosis was made, by examination of sections of the appendix, it seemed probable that all information possible had not been obtained from the blood count made by an interne on February 25 and recorded simply as leucocytes, 8,050; polymorphonuclears, 62 per cent; lymphocytes, 38 per cent. Consequently the patient was asked to report for a blood examination which she did on April 1, 1921. Her leucocyte count at that time, done by the writer, was 5,600; polymorphonuclears, 24 per cent; small lymphocytes, 52 per cent; large mononuclears, 7 per cent; eosinophiles, 17 per cent. A stool brought in was carefully searched but no ova were found.

The patient sailed for Scotland in May, 1921, bearing a record of her case to Professor Jonathan Meakins, University of Edinburgh. A report from him stated his concurrence in the diagnosis of intestinal type of bilharzia. "I think it probable that the parasite has become lodged in the muscular coat or probably the subperitoneal layers where it continues to exert a systemic reaction as evidenced by the eosinophilia, although not discharging ova into the lumen of the bowel. Professor Ashworth could find no ova in the stool." He concurred in Professor Meakins' opinion. Sodium antimony tartrate was given intravenously in ascending doses of a 2 per cent solution every 2 days beginning with 1 cubic centimeter. When a 4 cubic centimeter dose was reached, no further increase was made. After 7 doses the patient had taken a total of 22 cubic centimeters. Each dose was mixed with 50 cubic centimeters of normal saline.

Patient returned to New York in July, 1921, free from all symptoms. Abdominal and pelvic examination negative. Eosinophilia, 10 per cent. Three doses of 2 cubic centimeter each, of sodium antimony tartrate, were given intravenously July 12 and 15, and August 9. Eosinophilia August 9, 8 per cent. Patient had by then gained in weight and strength and tiring of treatments, refused more.

On May 2, 1922, the patient's urine was normal. Her blood count was as follows: red cells, 4,300,000; hæmoglobin, 85 per cent; white cells, 10,100; polymorphonuclears, 68 per cent; small lymphocytes, 23 per cent; large mononuclears, 7 per cent; eosinophiles, 1.5 per cent; basophiles, 0.5 per cent.

The patient went to Scotland again in June, 1922, and a report from Professor Meakins, dated August 10, 1922, stated that she was in excellent health and that careful observation failed to disclose any evidence of bilharzia remaining.

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A THIRD OMENTUM

By M. I. BIERMAN, B.S., M.D., and W. M. JONES, M.D., F.A.C.S., St. Louis, Missouri
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THERE has come to our attention a slight deviation from the usual development of the gastrohepatic omentum which we believe to be of sufficient importance to bring before the profession, especially inasmuch as no reference could be found in the literature to this very unusual condition. During the routine work at this station, we have chanced upon two cases in each of which there was an additional omentum much like the greater omentum, but instead of being dependent from the transverse colon was dependent from the lesser curvature of the stomach. At operation no pathological conditions of any kind were found in the upper half of the abdomen. The additional loop of omentum, therefore, was not the result of an inflammatory condition in which there had been a separation of omentum in an attempt to localize an inflammatory process, but appeared to be a distinct developmental variation.

Not being content with our inability to find any mention of this rare condition in the literature at our command, we wrote to Dr. Arthur E. Hertzler, Kansas City, Missouri, asking him if he had ever come across this anomaly. His reply was as follows:

"I am very much interested in your anomaly of the omentum. I have never seen anything so extensive. One sometimes sees embryos in which there is a folding downward of the lesser omentum somewhat in imitation of the usual down-looping of the great omentum. I have seen this down one inch or so in the adult stomach, but not down as far as yours. One sees, too, sometimes, a separation of the peritoneum from the stomach, much as one sees often about the cæcum after appendicitis. This is due to subperitoneal changes. I know of no literature on the subject. I have a card index of some ten thousand papers, and I do not remember seeing anything on the subject in that list."

CASE REPORTS

Case 1. E. T. B. The mother living and well; the father dead, 76, influenza; three brothers and two sisters living and well; two brothers dead, one of typhoid fever and the other killed. Maternal uncle died of cancer. No tuberculosis or insanity in family history.

Chief complaint: gnawing pains in stomach; tenderness in epigastrium; belching; eructation; constipation; occasional headache.

Patient had measles during childhood; small-pox at 20 years of age; machine-gun bullet in back, October 2, 1918; Neisserian infection March, 1921.

In December, 1918, patient was sent to Base Hospital No. 14, Mars-Sur-Allier, France, and received treatment for one month for "stomach trouble." First year after discharge worked at odd jobs around hotels and restaurants. In May, 1920, was under government observation for "stomach trouble." Believed it was growing worse.

Physical examination. Height 68 inches; weight 173 pounds. Examination negative except as follows: Pharynx congested; tonsils enlarged; teeth in poor condition. Blood pressure: systolic 140, diastolic 90. Tenderness over McBurney's point. Knee jerks equal but exaggerated. Diagnosis: appendicitis, chronic; pharyngitis, chronic; gingivitis; tonsillitis, chronic; dental caries.

Operative notes. A right rectus incision was made through skin and superficial fascia. The right rectus muscle was split. The abdomen was opened. The spleen, kidneys, intestines, stomach, duodenum, gall bladder, and liver were examined. The appendix was removed. Pathology: lesser curvature of patient's stomach was absolutely free from any appearance of ulceration. He had what we may consider a third omentum attached along the lesser curvature of the stomach and hanging down over the front of the stomach to about half its width. The gall bladder was apparently normal. There was a marked cholecystoduodenal ligament which is an anatomical affair rather than adhesions. The duodenum was rather large. The appendix was large and acutely kinked about one inch from its tip. The walls were markedly thickened. Contained liquid fæces.

Case 2. F. W. B. Father living and well; mother dead, cause unknown; four sisters living and well.

Chief complaint: feeling of fullness in abdomen following ingestion of meat and rich food; pain in lower abdomen when he exerts himself.

Patient had measles and mumps in childhood. No other illnesses until submucous resection at

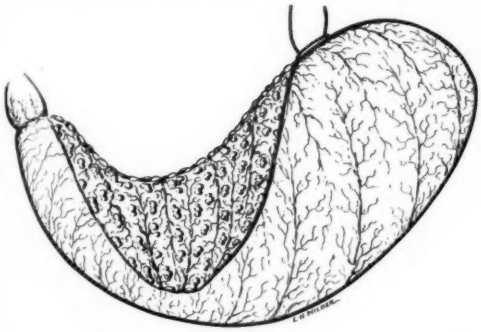

Fig. 1. Semidiagrammatic sketch of condition found in Case 2.

Ft. Riley, Kansas, in December, 1917. Influenza in 1918; was confined to barracks for 2 weeks. In hospital about 3 weeks at Vichy, France, with tonsillitis, in March, 1919.

Since discharge patient has had constant pain in right side, as well as ulcers on right leg. He says he has never been sick a day in his life until induction into army. Thinks present condition was due to exposure and is getting worse. Claims to have weighed 180 pounds when he went into service, and 120 pounds on discharge.

Physical examination. General appearance: rather poorly nourished. Weight 124 pounds. Height 68 inches. Clinical findings negative except as follows: The thyroid is slightly enlarged; palpebral fissure wide; suggestive of von Graefe's sign; pharynx injected; tonsils embedded. Chest: hyposthenic type. Lungs: percussion note slightly impaired in left apex and breath sounds harsh throughout. No râles. Tenderness in epigastrium and left upper quadrant. Can feel large bowel and gas in left upper quadrant. Can hear gurgling of gas on pressure. Tenderness in right lower quadrant. Four small superficial ulcers in lower third of right leg, inner aspect. Numerous scars of healed ulcers on right leg.

Roentgen-ray report. Preliminary examination shows no gross pathology of kidneys or gall bladder. Fluoroscopic and roentgenographic examinations show stomach to be somewhat hypotonic, fish hook type, and somewhat ptosed. The movability of the stomach is normal and the peristaltic action is good. There is a small, constant filling defect near the pylorus on the lesser curvature. The duodenal cap is unusually large but regular in outline. No abnormalities noted. At 6 hours the head of the meal was in the descending colon and the tail in the terminal ileum. The stomach was empty. At 24 hours the meal extended from the cæcum to the rectum and at 48 hours the meal had been discharged. The colon appeared to be spastic. Conclusions: There is apparently an ulcer on the lesser curvature near the pylorus.

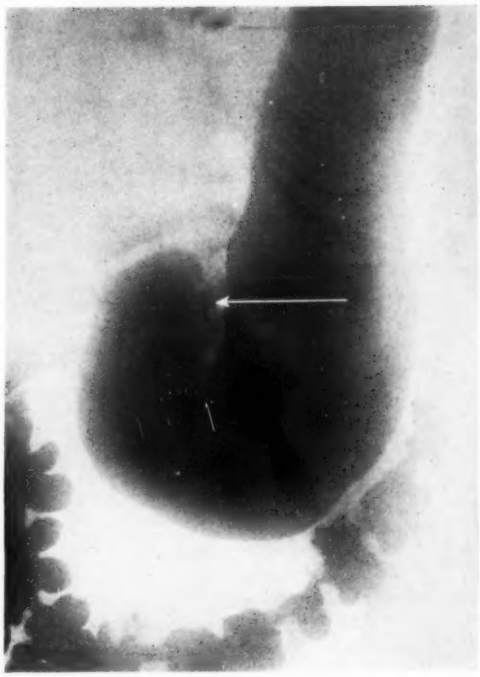

Fig. 2. Roentgenogram showing constant defect on lesser curvature, Case 2.

At operation the stomach was found to be normal in every respect. Over its anterior surface, however, there was a small triangular omentum containing a good amount of fat and an excellent blood supply. This small omentum was attached to the lesser curvature and extended from the pylorus to the cardia, not including, however, the entire cardiac portion of the stomach. In shape it was triangular, and its length was almost half that of the circumference of the stomach at the level of the incisura angularis. Figure 1 is a semidiagrammatic sketch. It appears that the omentum was curled up during the roentgenographic examination and produced a constant defect on the lesser curvature (Fig. 2). When found, it was still partly folded up but was straightened out without any difficulty.

The anlage of the stomach as found in the embryo is a minute, spindle-shaped piece of dilated gut, situated slightly cephalic to the yolk stalk. As the embryo enlarges, the dorsal

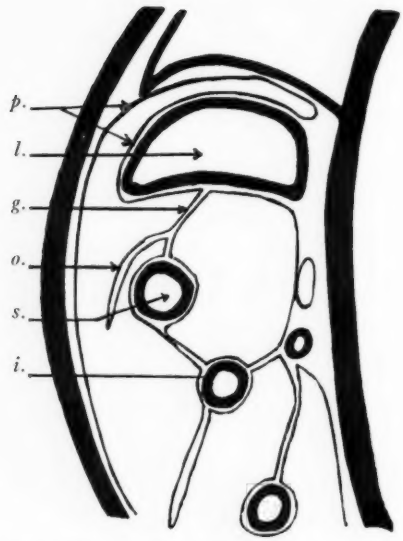

Fig. 3. Diagram showing position of *p*, peritoneum; *l*, liver; *g*, gastrohepatic omentum; *o*, third omentum; *s*, stomach; and *i*, large intestine.

side of the anlage grows more rapidly than the ventral side, which brings about the formation of the greater and lesser curvatures. The dorsal mesogastrium attaches the greater curvature to the dorsal body wall and the ventral mesogastrium attaches the lesser curvature to the ventral body wall. A ventral mesentery is present only at the cephalic end of the duodenum and is continuous with the ventral mesogastrium. As the position of the stomach changes, the duodenum rotates so as to lie obliquely across the abdominal cavity and finally assumes a nearly transverse position as is found in the adult. Its mesentery fuses with the peritoneum of the dorsal body wall. The ventral mesentery extends only a short distance caudal from the diaphragm. The liver grows into the caudal portion of the diaphragm, and since the ventral mesentery is immediately continuous with the diaphragm in this region, it becomes attached to the under surface of the liver. That is to say, it forms a connecting band between the lesser curvature of the stomach and the liver, and, at the same time, extends for a short distance along the duodenal portion of the intestine. In rotating to the left, the stomach carries with it the ventral mesentery, and this is drawn toward the liver and assumes a position practically at right angles to the sagittal plane of the body. In this position it forms the gastrohepatic and duodenohepatic ligaments, otherwise known as the lesser omentum. In embryos there is found very occasionally an out-pouching of this lesser omentum much like the looping of the great omentum. In the cases here reported, this occasional out-pouching of the lesser omentum was exaggerated to such a degree that when the adult condition of the stomach was attached there apparently was formed a third omentum which hung like an apron over the anterior surface of the stomach.

An anatomical developmental anomaly such as this cannot be of great clinical importance due to its rarity. Roentgenographically, one of them produced a constant defect of the gastric contour on the film which could very easily be mistaken for an ulcer. However, its greatest importance would be at operation where it would have to be differentiated from an inflammatory process.

DEPARTMENT OF TECHNIQUE

ENDOTHERMY, A SURGICAL ADJUNCT IN ACCESSIBLE MALIGNANCY AND PRECANCEROUS CONDITIONS[1]

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IT is my privilege to discuss in this paper endothermy, a treatment of accessible malignancy which greatly reduces the danger of metastasis and the likelihood of recurrence by removing the growth as a necrotic mass instead of as a group of viable cells.

Endothermy is the production of heat in the tissues from within. It is the localized production of heat in response to the many oscillations of the high frequency current, and it is used in surgery for its desiccating or coagulating effect upon the tissues.

The term endothermy has been adopted to identify this particular mode of procedure, and to distinguish its technique from all other forms of cauterization. There is considerable confusion in the terminology of this and other procedures, so that it is today loosely spoken of as the electric needle, the electric cautery, fulguration, diathermy, coagulation, sparking, etc., not one of which names is fully descriptive of endothermy.

I particularly wish to make the point that endothermy is not fulguration; while to say that it is coagulation limits its scope to a small fraction, since for each time we coagulate we desiccate many times. I feel, therefore, that acceptance of the name endothermy, monopolar or bipolar, will result in a needed standardization of the nomenclature of the varied applications of electricity to surgery. Devised and developed by Dr. William L. Clark of Philadelphia, endothermy consists of two different processes, and has, over a period of 15 years, proved of ever-increasing value in the work to which it is applicable.

In the more superficial cases where the lesion is localized and does not extend into the depth of tissues, and where marked destruction is not indicated, monopolar endothermy is used under local anæsthesia, preferably freshly prepared ½ per cent novocaine. The result is desiccation. Its technique is simple. With the monopolar current, a current of high voltage and low amperage, from an Oudin resonator of a high frequency machine, we induce in the tissues just enough heat to cause a localized dehydration. This is accomplished with an ordinary sewing needle held in a suitable handle. With the newer machines we have a fineness of control which allows us to apply the heat where we will, and to what degree we will in all accessible lesions. So delicate is the adjustment it can be throttled down practically to a pin-point area, permitting one to work in the cornea of the eye or on the vocal cords. The method is, therefore, ideal for removing those small tumors of the eyelids which can be taken off at their base without destroying much of the surrounding tissue. It does away with the contracted scar and consequent ectropion.

Endothermy neither chars nor burns, and indeed can be executed through a piece of white paper without marring it. It is this minimum of trauma and slight secondary inflammation which permits the removal of diseased tissue and benign and malignant growths with a superior cosmetic result. This is of particular importance in lesions about the face, neck, and hands. We have in this a refined method for removing those commoner blemishes, which may become malignant, the various kinds of warts, moles, and pigmented nævi. This method has proved of great value also in treating lupus vulgaris, tuberculosis of the cutis, and all forms of tuberculosis of skin and mucous membrane. Vernal catarrh responds to the brushing over of this current, as does leucoplakia. The precancerous dermatoses, including the various forms of keratoses, acanthoma, chronic ulcers, papilloma, fibroma, lupus erythematosus, X-ray dermatitis, and other lesions of the skin and mucous membranes which may become epitheliomatous, as well as epitheliomata themselves, can be removed by endothermy.

It should be remembered that endothermy differs from other methods of cauterization by heat in that the active electrode is cold when

[1] Read by invitation before the American Electrotherapeutic Association, New York, September 19, 1922.

Fig. 1. Case 1. (at left). Rapid growing prickle-cell epithelioma of the floor of the mouth, showing marked areas of induration and crater-like ulceration.

Fig. 2. Case 1. Immediately following one treatment by bipolar endothermy growth was excised as a necrotic mass. Under surface of tongue is adherent to the floor of the mouth. After two years, there is no evidence of recurrence.

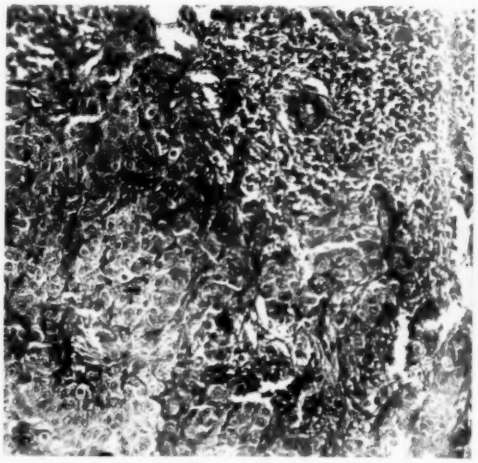


Fig. 3. Case 1. Section showing nests of cells in squamous-cell epithelioma of floor of mouth.

applied. Heat comes from within by the resistance of the tissues to the current. It is, therefore, progressively penetrating according to the amount of current used and the length of time it is applied. This progressive penetration is in contradistinction to heat applied from without, as with the Paquelin cautery, the galvanocautery and fulguration as advocated by de Keating-Hart.

In monopolar work the needle should touch or rather lightly penetrate the lesion to be destroyed, while in treating deep-seated malignancy the needle should be inserted and thrust to whatever depth one desires to carry the destruction. For these deep-seated lesions bipolar endothermy is indicated. Here the heavier and more powerful currents are used and general anæsthesia is advised. Ether is preferable, but must be taken from the room while the current is in actual use.

By means of the d'Arsonval or bipolar current, one of low voltage and high amperage, lesions of larger size and greater depth are given the intense, penetrating action of this endogenous heat. The result is coagulation.

Heat is generated by connecting one pole of the machine to a well-wet, indifferent electrode under the patient's buttocks as he lies upon the table. The other pole, the active electrode, is attached to the handle in which is an ordinary sharp-pointed, steel darning needle of proper length and suitable shape. With this in hand any amount of coagulation necrosis can be described. In the squamous-cell variety of epithelioma and the more malignant and persistent forms of accessible cancer (particularly the lesions in and about the mouth, which metastasize early, are difficult of removal by the knife and are uncertain in their response to physical treatment) endothermy is of the highest value. Lip lesions are removed under local anæsthesia. Any portion of a tongue can be coagulated and immediately cut away. A floor-of-the-mouth cancer can be coagulated *in situ* and the necrotic mass removed in one operation. Bony structure, alveolus, hard palate and portions of the lower jaw likewise can be treated with the same degree of precision.

The following is a typical case of rapid-growing, prickle-cell carcinoma of the floor of the mouth.

Case 1. J. W., age 66, sailor, referred by Dr. W. B. Moodie of Valhalla, New York, reported that about 2 months previously a pimple had appeared under his tongue. He thought that the dental plate was irritating his mouth, but was assured by his dentist that this was not the case. He paid scant attention to the matter thereafter, but while he was at sea the pimple began to grow. On returning to New York he went to a hospital where "the doctor opened it and since then it has had a hole in it."

Examination showed an indurated mass, about 3 centimeters by 2 centimeters in size, involving the right side of the floor of the mouth. It was foul and had a crater-like ulceration at right of the frenum. It was painful and tender, but no palpable, cervical glandular enlargement could be made out. On June 2, 1921, under ether narcosis the entire mass was completely surrounded or isolated by bipolar endothermy. To establish this definite wall of coagulation necrosis around the malignant area, it was necessary in this case to coagulate through the frenum, the under surface of tongue, and the inner surface of right jaw. A section for the micro-

Fig. 4. Fig. 4. Fig. 5. Fig. 6.

Fig. 4. Case 2. D. G., age 66, squamous-cell epithelioma of nose treated by bipolar endothermy and excised as a necrotic mass.

Fig. 5. Case 2. Six weeks after operation.
Fig. 6. Case 2. Six months after operation.

scope was then removed with impunity after which the whole mass was coagulated *in situ*. The dead tissue was next removed by scissors and the entire cavity seared over with the current to produce a further penetration of the heat. The lingual artery was not ligated.

Patient returned to room in good condition. Next day there was considerable swelling of tongue and a profuse flow of saliva, but he was free from pain and was able to take liquid nourishment. He left the hospital on the third day in fairly good condition, although toxic absorption had rendered him very cachectic in appearance, with skin of a dark, yellowish hue, both of which conditions cleared up rapidly.

Sloughing of the remaining necrotic tissues began shortly afterward and was complete in the third week, although a piece of bone sequestrated from the inner surface of the jaw in the sixth week. Wound healed completely, and patient has remained free from pain. There was early return to normal diet and a gain of 15 pounds in weight within 3 months. Both sides of patient's neck were treated with deep penetrating X-ray as a postoperative prophylactic measure.

If we consider the technique of the treatment, we shall understand the particular advantages of endothermy. The first step in the procedure is to describe in the healthy tissue a protective ring of destruction around the malignant area. That is, before a malignant area is touched it is completely surrounded by a wall of coagulation necrosis, which shuts off and destroys the blood vessels and lymphatics to and from the affected part. After this the entire lesion is destroyed and removed. Just how much current shall be used and for how long, the operator must learn by experience. Dosage is, however, always under accurate control and conservatism demands that one overtreat rather than undertreat, for a stimulating dose is worse than no dose at all.

It is not difficult to understand that this line of destruction drawn about the malignant area to cut off blood vessels and lymphatics cuts off, also, the sensory nerves, and as the malignancy is removed the pain is alleviated. The value of

Fig. 7. Case 2. One year and six months after operation. No sign of recurrence. Artificial nose made by Mr. O. A. Ilkins, of New York, formerly of Walter Reed Hospital.

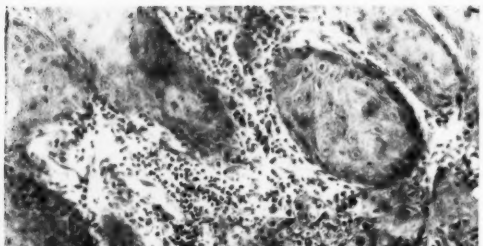


Fig. 8. Case 2. Section of nose case showing infiltrating mass of prickle cells with whorl and pearl formation and inflammatory reaction about them.

endothermy, therefore, in that large group of so-called inoperable carcinoma is very great. Though used in such cases without hope of cure, it provides an alleviation of suffering. In addition, the sterilizing effect of the heat upon a foul, discharging area is appreciated by the patient, for it renders his wound less offensive. One can scarcely overestimate the importance of these features of the method, particularly in the treatment of lesions in and about the mouth. In such cases, the small remaining slough comes away in from 2 to 3 weeks, and the area is completely healed within a few days thereafter. Patient can thus enjoy that early return to normal diet which is of the highest importance, since most of these cases are markedly cachectic, anæmic, and badly run down. Their chief postoperative need is nourishment.

CASE 2. D. G., section hand, age 66, referred by patient M. H., reported that about 3 months ago he noticed a small sore on the left side of his nose which rapidly increased in size. His physician applied salves and lotions and finally sent him to a hospital where he had five X-ray treatments. The lesion grew rapidly and became painful. The Wassermann was negative. On November 4, 1921, under complete anæsthesia, the lesion was treated with bipolar endothermy and then excised as a necrotic mass. Convalescence was uninterrupted and photographs indicate the progressive course of nature's filling-in process after the operation.

If the work is properly done there should be no hæmorrhage. Deep penetration beyond the malignant area renders the tissue bloodless. Should by any chance a bleeding point be encountered, it is easily controlled by focussing the current on it for a second or two until the heat is sufficient to stop it. Secondary hæmorrhages do not often occur. However, they have happened in isolated cases and were I to work in close proximity to a large blood vessel I should do a preliminary ligation.

In drawing our conclusions I would remind you that cancer begins as a localized disease and is then curable. The dangers of cancer lie in metastasis and the likelihood of recurrence. By endothermy, a destructive process, we greatly reduce these dangers. Our aim is to destroy, *before excising*, all morbid disease tissue. The intense heat renders the wound sterile and affords nature the opportunity to reproduce her own, by her own constructive, healing processes. These processes will, after treatment by endothermy, accomplish their results in less time, and with infinitely less suffering than characterize convalescence after the use of other physical measures.

TECHNIQUE OF ENLARGED PYELOTOMY FOR RENAL CALCULI

By DANIEL N. EISENDRATH, A.B., M.D., F.A.C.S., Chicago

THE majority of urologists prefer pyelotomy to the classical nephrotomy because of the late complications, such as hæmorrhage, which may follow such a nephrotomy.

Concomitant with this more widespread application of pyelotomy in the removal of calculi, the need has been felt of a larger opening in the renal pelvis than one obtains through the ordinary pyelotomy incision (Fig. 1).

There is some difference of opinion as to who first suggested division of the parenchyma of the kidney at the hilus (posterior aspect) in order to be able to enlarge the incision in the renal pelvis and enable larger calculi to be delivered by this method. It is self-evident that such wider exposure of the intrarenal portion of the pelvis would greatly extend the field of pyelotomy and enable us to deliver calculi by this route which hitherto seemed impossible except by the classical nephrotomy incision, that is, bisection of the kidney.

Marwedel is given credit in the German literature for suggesting an extension of the ordinary pyelotomy. In a recent communication[1] Marwedel states that he prefers an anterior pyelotomy in cases of large calculi where it is necessary to prolong the incision into the parenchyma, because the danger of injury to the retropelvic artery is much less. Kelly[2] states that "the ordinary pyelotomy incision can be safely enlarged in an oblique direction (Fig. 2), downward and outward, over the posterior surface of the kidney, and then if necessary combined with nephrotomy (*3–3* in Fig. 2). The oblique incision (*2–2* of Fig. 2) avoids injury to the retropelvic artery."

Marion[3] reports several cases in which he was able to deliver relatively large calculi through an enlarged pyelotomy incision. The direction in which the ordinary pyelotomy is extended into the parenchyma depends upon the long axis of the calculus. He has divided the retropelvic artery in all of these cases without damage to the parenchyma.

[1] Zentralbl. f. Chir., 1920, xlvii, 1034.

[2] Diseases of Kidney, Ureters and Bladder. New York: William Wood and Co. 1914, vol. i, 441.

[3] J. d' urol., 1922, xiii, 1.

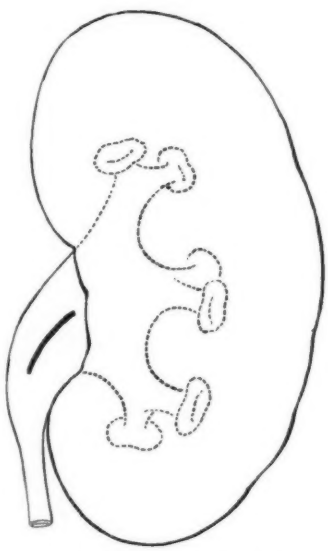


Fig. 1 (at left). Extent of ordinary pyelotomy incision in relation to extrarenal and intrarenal portion of pelvis.

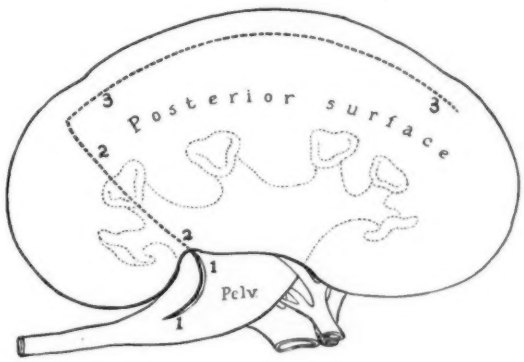


Fig. 2. Extension of ordinary pyelotomy incision (*1–1*) into parenchyma of posterior half of kidney as suggested by Kelly. *2–2* and *3–3* represent the direction of the extension of the incision into the parenchyma of posterior half of the kidney. The oblique incision, *2–2*, avoids injury to retropelvic artery.

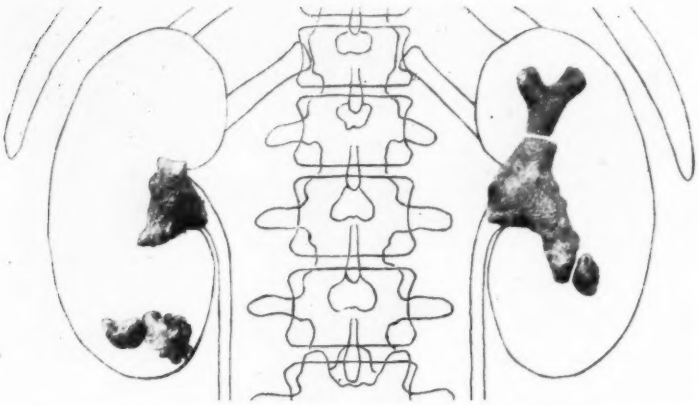


Fig. 3. Bilateral renal calculi. The greater portion (central part) of the left-sided branching calculus (2.5 centimeters by 4.5 centimeters) was removed by enlarged pyelotomy, and the two smaller segments through nephrotomy incisions.

In a recent case I was able to deliver the greater portion (2.5 centimeters by 4.5 centimeters) of a branching calculus (Fig. 3) through an enlarged pyelotomy and the remainder of the calculus through two small nephrotomy incisions. Had I not been afraid to tear the neck of the primary calyces (superior and inferior) it would have been easy to deliver the entire calculus through the enlarged pyelotomy incision.

If the retropelvic artery is doubly ligated and divided, enlarged pyelotomy becomes practically as bloodless as ordinary pyelotomy.

Ligation of the retropelvic artery is not difficult if the overhanging edge of the parenchyma is retracted (Fig. 6) and I feel certain that my suggestion to do this before the pyelotomy incision is enlarged (Fig. 5) will greatly aid the operator by enabling him to work in a bloodless field.

The retropelvic artery (Fig. 4) supplies a comparatively small portion of the parenchyma and ligation at the point suggested (Fig. 6) would even theoretically only involve about one-half of the area indicated in Figure 4. Marion, in the article quoted above, is of the opinion that division of the

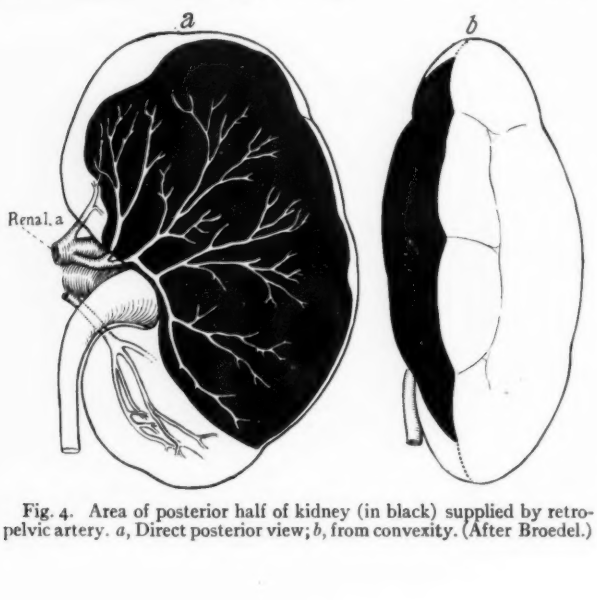


Fig. 4. Area of posterior half of kidney (in black) supplied by retropelvic artery. *a*, Direct posterior view; *b*, from convexity. (After Broedel.)

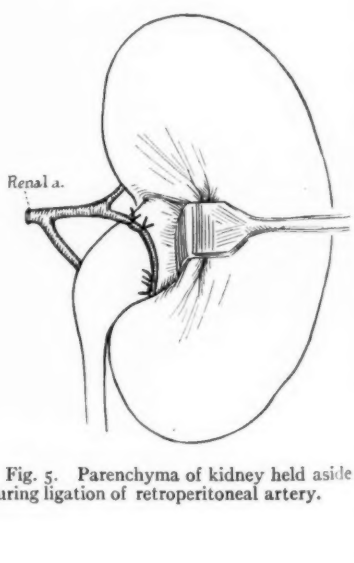


Fig. 5. Parenchyma of kidney held aside during ligation of retroperitoneal artery.

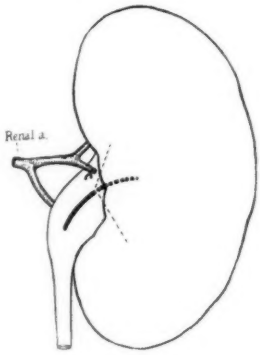


Fig. 6.

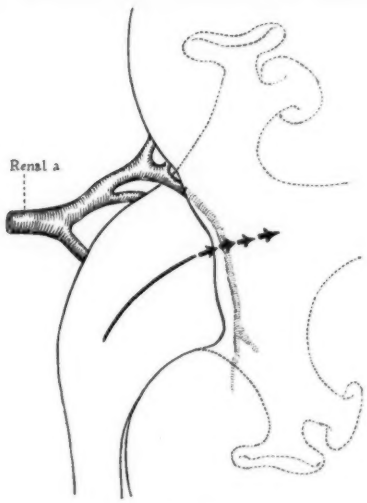


Fig. 7.

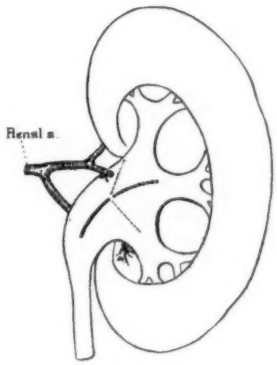


Fig. 8.

Fig. 6. The retropelvic artery has been doubly ligated and divided, thus permitting extension of incision in any direction into the renal parenchyma without hæmorrhage.

Fig. 7. Detailed view of enlarged pyelotomy incision in relation to retropelvic artery and parenchyma at hilus of kidney. Extension of the ordinary pyelotomy incision into the parenchyma indicated by the four arrows. It is understood that incision may be extended in any direction.

Fig. 8. This illustration was made from a specimen in which the parenchyma of the posterior portion of the kidney only with renal pelvis had been removed after double ligation of the retropelvic artery, and removal of the intervening portion. Note how the entire intrarenal portion of the pelvis could be opened by the enlarged pyelotomy incision.

retropelvic artery does not result in any damage to the kidney. From my own experience in the case recently operated upon (Fig. 3), I can endorse this view that the area supplied by the ligated vessel will receive sufficient blood from adjacent arteries which are branches of the system derived from the prepelvic vessels.

The steps of the technique are as follows:

1. If the usual pyelotomy incision (Fig. 1) does not suffice to deliver the calculus, the parenchyma at the hilus is retracted as shown in Figure 5 and the retropelvic artery isolated and doubly ligated.

2. The original pyelotomy incision (Fig. 6) can now be enlarged in any direction which is necessary to enable one to deliver the calculus or to explore the primary calyces.

3. After extraction of the calculus (or calculi), the enlarged pyelotomy incision is closed with interrupted sutures of fine chromic catgut and either the peripelvic fat placed over the suture line or a free transplant of fat taken from the subcutaneous layer of the parietal incision. It is not necessary to approximate the cut edges of the renal parenchyma.

The additional exposure of the intrarenal portion of the pelvis obtained by the above technique can be readily seen in Figures 7 and 8. The former represents a detailed view of the field in enlarged pyelotomy. The retropelvic artery is seen in its relation both to the parenchyma which covers it and to the enlarged pyelotomy incision. Figure 8 was drawn from one of my specimens of a renal pelvis filled with paraffin and demonstrates the additional exposure of the intrarenal portion of the pelvis obtained after ligation of the retropelvic artery and prolongation of the pyelotomy incision into the intrarenal portion of the pelvis. The heavy dotted line represents the direction in which the pyelotomy incision is most frequently extended and the light dotted lines indicate the other directions in which the incision can be extended varying with the long axis of the calculus.

APRON USED IN PERFORMING BOWEL AND STOMACH ANASTOMOSIS

By FRANK H. LAHEY, M.D., F.A.C.S., Boston

THE apron here described has been used by us for considerably over a year, and provides a means of keeping the field quite free from contamination during bowel or stomach anastomosis.

It consists, as seen in the illustration, of two sheets of rubber dam cemented to two pieces of rubber tubing which cover outer blade of each clamp or outer jaws of a three blade clamp.

Figure 1 shows the apron attached to one clamp. Figure 2 shows the aprons attached to both clamps and the method of isolating the anastomosis.

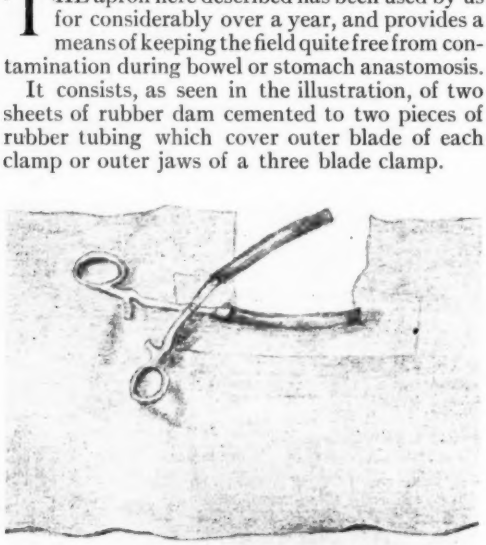


Fig. 1.

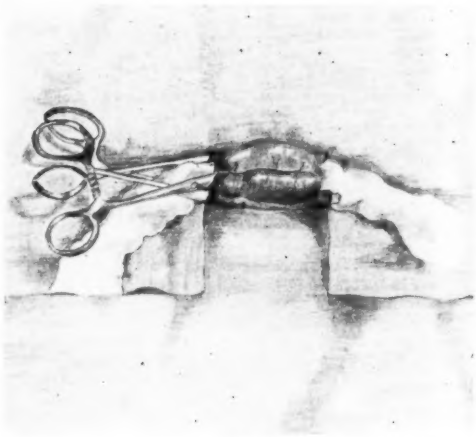


Fig. 2.

AN IMPROVEMENT ON THE VOORHEES BAG

By EDWARD L. CORNELL, M.D., F.A.C.S., Chicago

IT has always been more or less difficult to determine the amount of cervical dilation following the insertion of a Voorhees bag. To overcome this, Dr. J. B. DeLee and myself have improved the bag by placing rubber ridges around it. The ridges have been placed equidistant from the top of the bag and project just enough to be felt readily on rectal examination. The examining finger follows up the bag from the apex to the cervix and then is carried downward counting the number of ridges which protrude into the vagina. The bag is said to be out one, two, etc., ridges. If all of them can be felt below the cervix, we know the cervix is dilated almost to the full size of the bag. This bag gives a much more accurate idea of the cervical dilation.

Photograph showing ridges on bag.

It was found necessary to place the ridges around the entire bag. The ridges do not interfere with the progress of dilation, nor do they cut the cervix as they are protruded.

EDITORIALS

SURGERY, GYNECOLOGY AND OBSTETRICS

FRANKLIN H. MARTIN, M.D. ..... Managing Editor
ALLEN B. KANAVEL, M.D. ..... Associate Editor

MAY, 1923

LUNG ABSCESS

RECENT medical literature suggests that lung abscess is a much more frequent condition than it was formerly. This increase is due in part to the fact that many cases owe their origin to the operation of tonsillectomy performed under general anæsthesia, and many more tonsillectomies are probably now being done. It is due also in part to the fact that progress in the use of the X-ray has permitted the exact recognition of many more cases than was formerly possible.

Abscess of the lung constitutes one of the most difficult conditions to treat satisfactorily which occurs in the category of non-malignant affections. The unfortunate victim of pulmonary suppuration may survive the period of danger while the abscess is acute, only to become a chronic invalid subject to frequent attacks of fever, with offensive breath and sputum, and more or less frequently recurring pulmonary hæmorrhages. If he does not die of pulmonary hæmorrhage, he may end his unhappy existence with a brain abscess or meningitis. The ease with which a rib may be resected and an opening made into an adherent lung has made the treatment of lung abscess appear as a simple matter to the uninformed. Fortunately there are some cases which respond to this treatment in a gratifying manner. But there are many others on the contrary which pass into a condition of chronic invalidism even although they have been relieved of a large collection of pus. Any one who follows up his cases operated upon is aware of the full truth of this statement.

If a large abscess is complicated by an empyema, the prognosis at once becomes more grave as regards both life and chronicity. For this reason the use of the aspirating needle is to be avoided unless one is sure of the existence of adhesions, in order to escape the possibility of an infection of the pleura from leakage along the track of the needle. The only safe way in which to use an aspirating needle in searching for pus in a lung abscess is to insert it through an area in which it has already been positively determined that the lung is firmly adherent to the chest wall. Generally this point can be determined only at operation, or by a diagnostic pneumothorax.

Many cases of lung abscess do not require open surgical drainage. Many will make a complete recovery by the use of proper postural drainage. Others will recover satisfactorily with the aid of an artificial pneumothorax. It is difficult at present to define accurately the standards which should determine in any case whether open drainage should be used or some non-operative procedure. In cases associated with a foreign body, it is advisable to remove the foreign body through a bronchoscope if it is readily accessible to removal by this method. After the removal of the foreign body either by the

act of coughing or by the bronchoscope, the abscess should be treated conservatively because usually such cases will heal readily. Conservative treatment should also be tried in all cases of comparatively recent duration in which the patient is not toxic and in which the amount of purulent sputum indicates that a fairly adequate drainage exists through a bronchus. On the other hand, surgical drainage should be performed in all cases of acute abscess in which a reasonable trial of conservative methods has resulted in no progress, and particularly if the patient's general condition has become worse or if the abscess has grown larger. Large abscesses which show a definite fluid level with the X-ray are generally treated more successfully by surgical drainage.

In draining an acute lung abscess, care should be taken to insure the establishment of firm adhesions between the lung and the chest wall. After the subperiosteal removal of a rib the lung can sometimes be seen through the parietal pleura to be gliding up and down with the movements of respiration. Such a lung is not adherent. If any doubt exists it is better to consider the lung as not adherent and to take steps to create adhesions. This can be accomplished by sewing the lung to the parietal pleura or by producing an aseptic inflammation of the unopened parietal pleura by the use of ordinary sterile gauze packing, iodine or iodoform gauze, light scarification with an actual cautery, etc. With any of these methods, at the expiration of from 4 to 8 days the adhesions are sufficiently firm to permit drainage of the abscess without the danger of leakage of pus into the pleural cavity. No anæsthetic is required at the second stage. In other cases it will be of advantage to open the pleura widely at the time of the first operation in order to permit exploration. Lockwood has recently advocated the frequent use of free exploration in these cases to be followed by delivery of the abscess-containing tissue outside of the pleural cavity. Later the whole extrapleural mass is excised. This method would seem attractive for certain cases, but it would seem unapplicable when the abscess is located near the hilus.

An abscess which has become chronic presents a very difficult condition to treat satisfactorily. Here we are no longer confronted with a single cavity containing pus, but instead with a firm mass of induration with often many small abscesses which have become shut off from the main drainage track. The bronchi and bronchioles are often greatly thickened by fibrous tissue, and masses of granulation tissue which bleed easily are often found protruding into the lumina of the bronchi. At other times the whole portion of involved lung may be honeycombed with pus. The patient usually presents a picture of abject misery, with frequent attacks of fever, copious foul sputum, pulmonary hæmorrhages, emaciation, clubbing of the fingers, etc. Drainage in such cases usually accomplishes little, because there is no single cavity to be drained. The establishment of a permanent bronchial fistula will sometimes afford symptomatic relief, but in other cases it will accomplish nothing. Hedblom and Willy Meyer have had some good results with this method. Theoretically, however, the ideal procedure is to remove all the diseased tissue, just as is done in chronic appendicitis or chronic cholecystitis. But the usual operation of lobectomy is accompanied by a very high mortality; notwithstanding this fact, Lilienthal and others strongly advocate it in selected cases. In an attempt to avoid the high mortality of the ordinary lobectomy in these cases, I have recently tried burning out the whole portion of involved tissue with the actual cautery after freely exposing it. The procedure amounts almost to a lobectomy

performed with the cautery. The great advantage over the usual lobectomy is that it is not necessary to separate the adherent lung from the chest wall and thereby expose the pleural cavity to infection. In the few cases in which I have tried it, the procedure has not only been well tolerated but it has given gratifying results. The danger of late hæmorrhage exists but so far I have not encountered it.

EVARTS A. GRAHAM.

THE RELATION OF THE CLINIC TO THE LABORATORY

IN the development of any new thing it is the usual practice to overemphasize its value. The presentation of the claims of the laboratory has undergone this tendency. This was deemed necessary in order to impress the clinician with its importance. The young man does not need such an emphatic introduction. He has taken to it naturally just as most students are attracted to those subjects which they acquire with the least effort. The laboratory appeals to him because it appears as being something tangible and definite, while the term "clinical experience" is something offensive because it is intangible and seems a reflection on his immaturity; something withheld from him by the nature of things, at least for the time being. He has an inward feeling that the laboratory will enable him to beat the game; something which shall substitute for clinical observation. If he can find the tubercle bacillus in the sputum it makes no difference whether or not he is an expert in physical diagnosis. He fails to appreciate the negative side of the problem. To him the search for a specific organism which he fails to find is evidence that such a disease is not present. Curiously enough here the young man meets a common ground with the old clinical man. He, too, fails to appreciate the difference between positive and negative evidence and is quite as apt to stress negative evidence. Worst of all, the clinical man gives little heed to the ability of the laboratory man, and the young man fails to grasp the fact that the finer points in laboratory technique are not acquired in a day. There is no factor more apt to lead to error than an insufficiently prepared laboratory man or a surgeon who cannot foretell with reasonable certainty what the laboratory will show. The laboratory should be regarded as a place where specific questions may be passed on, seldom for the determination of a final diagnosis. It is not belittling the laboratory man to insist that his department is but one leg of the tripod upon which the diagnosis must rest. The other legs are the history obtained by the surgeon and the physical findings revealed at the examination. Sometimes the one, sometimes the other, is the most important. The laboratory findings may be positive, the clinical history may be typical, and the physical findings may leave no question as to the nature of the disease. It must be ever remembered that a tripod is of no use unless it carries something. In this simile it must be the surgeon's brains that surmounts this tripod; the clinical judgment of the surgeon, the intangible something.

To make use of the evidence the surgeon must know the limitations as well as the positive factors of the laboratory. This knowledge can be acquired only by personal contact with the laboratory. This knowledge can be acquired only by long contact, just as history and physical findings can be appreciated only by prolonged personal clinical experience. To paraphase a well-known remark of the distinguished Fenger, the laboratory will not assume its proper place in surgical practice until surgeons "tread a path between the clinic and the laboratory and from the laboratory to the clinic." ARTHUR E. HERTZLER.

MASTER SURGEONS OF AMERICA

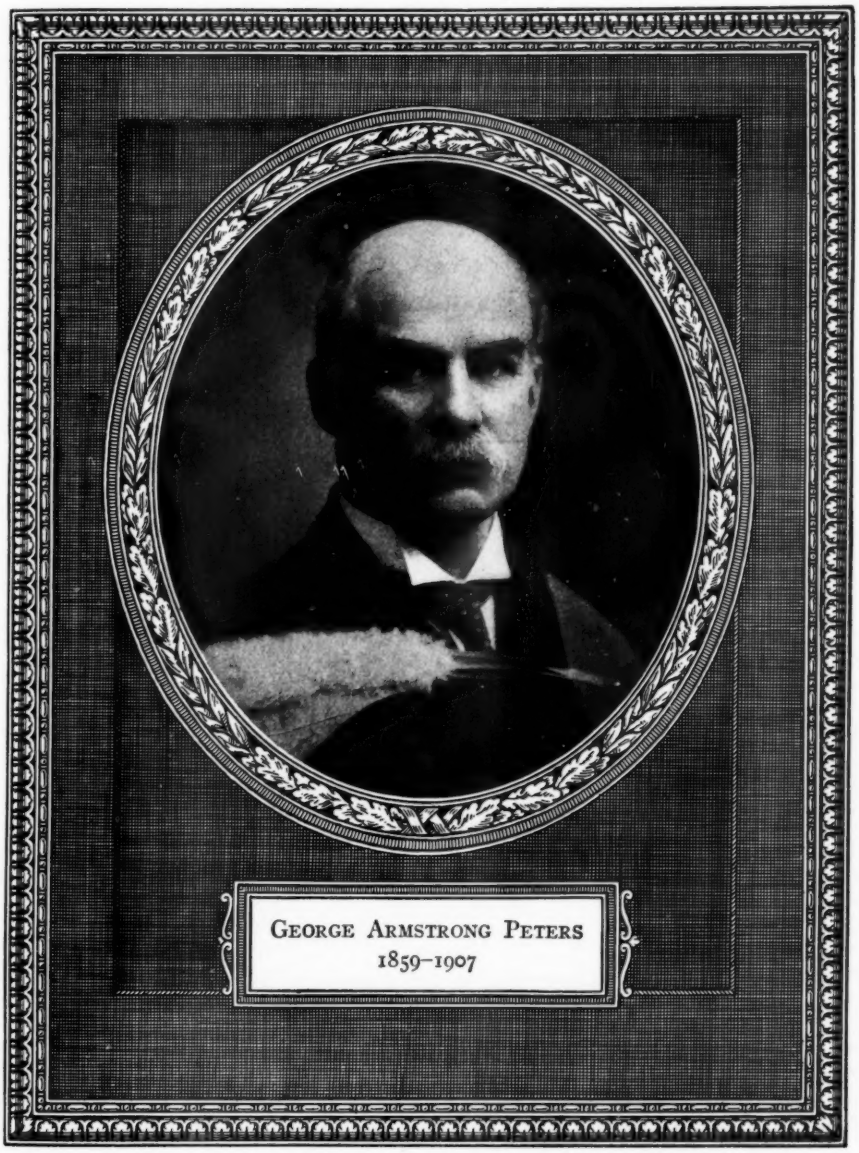
GEORGE ARMSTRONG PETERS

IN the death of Dr. George Armstrong Peters, in the prime of life, and at the zenith of his professional career, Canada lost one of her most brilliant surgeons, and one of the very best of her clinical teachers. George Peters had the very fortunate fate to be born of sturdy yeomanry parents in a country section. It is to be noted that he is one of many professional men in this young country who have worked their way to eminence with the wonderful heritage derived from this simple life, together with a high ambition, indomitable courage, and a willingness to work.

He had a good high school education, matriculated at the University of Toronto and entered the study of medicine in the old Toronto School of Medicine, graduating from the University of Toronto in 1886 with honors, winning the Gold Medal of the University and the Starr Gold Medal of that year. He was an interne in the Toronto General Hospital for one year, and afterward appointed demonstrator of anatomy, University of Toronto. Then followed a very short period of study in England, where he successfully passed the examinations of the Royal College of Surgeons and had the distinction of being the first Fellow of the Royal College of Surgeons in Canada. On his return he was appointed associate professor of surgery and clinical surgery, and after a most efficient service of eleven years, he was appointed professor of surgery and clinical surgery, a post which he filled with great distinction until his death.

Socially he was "an easy man to meet." He was genial and straightforward in his nature, and would not tolerate deceit or hypocrisy in his companions.

Professionally he was a master in his own work, of sterling character and rugged honesty, and fearless in his condemnation of whatever was unworthy of the highest traditions of the profession. As a surgeon he was distinguished for a combination of qualities which easily placed him in the first rank of Canadian surgeons and enabled him to take his place on an equality with the best in the profession the world over. He brought to each case a knowledge and ability gained by study, observation, and research which made him a keen and safe diagnostician. His mechanical ability and ingenuity combined with his artistic temperament made him a surgeon perfect in technique. He had developed very highly also the surgical instinct which is possessed by those who are born for the



GEORGE ARMSTRONG PETERS
1859–1907

task. These same characteristics showed to advantage especially in the plastic types of operation, and in his results in hare-lip and cleft palate he excelled all of his colleagues. He perfected many technical points in operative procedure which were never published, and are known and practised only among his immediate colleagues, or handed on personally through the same channel. It is a source of regret to many of his students that no permanent memorial volume was prepared when his memory was still green, and the touch of his spirit still upon us, so as to preserve for surgery generally, the valuable ideas known to so few. Certainly it is not known generally that the inflamed abdomen transmits both breath and heart sounds very clearly to the lowest part of the abdomen, quite to the symphysis.[1] Quite recently this point has been rediscovered, as noted in *Zentralblatt fuer Chirurgie*, Leipzig, where Hoefer recounts that the pulse is audible over the entire abdomen in cases of intestinal obstruction.

Many new devices, on the other hand, were published, notably his "New Operation for Procidentia," "The Extra-Peritoneal Transplantation of the Ureters for Ectopia Vesicæ," "A New Wrench for the Correction of Stubborn Deformities," "A New and Original Method of Making Casts," and "A New Method of Cutting Urinary Calculi." He also made a fair contribution to the advanced surgical literature of the day which showed his general knowledge of the work of others. He contributed articles on the "Surgery of the Rectum and Anus" to the *International Text Book of Surgery*, by Gould and Warren, and on "Inflammatory Affections of Bone," in Bryant and Buck's *System of Surgery*.

It was probably as a clinical teacher that Peters excelled, and only those who had the opportunity of sitting at his feet know the heritage he was able to transmit to posterity through his students. His clinics were noted for the clear cut and forcible method of expression which characterized his work, and his wealth of illustration and aptitude with chalk fixed on the mind and memory of his students lessons which never will be forgotten.

Peters insisted that every surgeon should have a hobby outside his work, and he practised this doctrine in his own life in several ways. He was an ardent military man, and after a service of some years as lieutenant and afterward as captain in the Governor General's Body Guard, he organized the Toronto Light Horse, and was appointed officer commanding with rank of lieutenant colonel. He was one of the best military riders in the country, and won many prizes for "tent pegging." His mechanical ability showed itself, outside his professional work, in his invention of a wonderfully ingenious, self-registering target for rifle practice, which received the greatest praise both in Canada and in England. He was a lover of horses and always kept a stable of excellent drivers and hunters. He was a member of the Hunt Club and a daring cross country rider.

He died March 13, 1907, at the age of 47, of angina pectoris. Even when he knew the end was approaching, he showed his indomitable courage and his

[1] The telephonic properties of the inflamed abdomen. Canadian J. M. & S., Toronto, 1902, December.

keenness for his professional work by dictating to his stenographer the character of the radiating pains of this dread disease as exemplified in his own case, and showed where they differed from the ordinarily accepted ideas. He was buried with full military honors, and as the "Last Post" sounded over his open grave, all those who mourned the loss of friend and colleague thought of his life rather than his death.

"His life was gentle; and the elements
So mixed in him that Nature might stand up
And say to all the world, 'this was a man!'"

CLARENCE L. STARR.

BOOK REVIEWS

CRITIQUE OF NEW BOOKS IN SURGERY

IT is commonly conceded by the medical profession in America that a chloroform anæsthesia is a very dangerous and treacherous procedure. We hear a great deal of chloroform poisoning, and its rather unique method of destroying life, and yet the large percentage of medical men have no conception of how this takes place.

Until we know more definitely the peculiar action of chloroform, we are in no position to improve the technique of its administration or to recommend that it be entirely dropped from ordinary usage. It is consequently very interesting to read the little monograph of Levy.[1] In this small volume is incorporated a tremendous amount of information, not only on the physical properties, pharmacology, and toxicology, of chloroform but on its peculiar action upon the essential structures of the body.

It has been the author's privilege to have administered many anæsthetics, and he has had the facility of observing the action of these various administrations. This, associated with a rather extensive study from the pharmacologist's point of view and animal experimentation, places him in a position to give us much valuable information. It might be of interest to state that the average death which occurs during a chloroform administration is not produced by the introduction of chloroform or what might be called chloroform poisoning. Most of these deaths take place at the very beginning of the anæsthesia or when it is withdrawn and are due to ventricular fibrillation.

The average medical man's conception of chloroform poisoning is that there is a sudden cessation of the heart's action, and that this is very soon followed by respiratory paralysis. The fact is that chloroform poisoning paralyzes the respiratory centers while the heart is still active. The misconception takes place by virtue of the fact that the average death is not brought about by chloroform poisoning, but as stated above, by ventricular fibrillation.

It is a generally conceded fact that the mortality in chloroform administration is about one in three thousand administrations. The author states that in a list of 13,393 chloroform administrations given by the anæsthetists of the British Medical Association, there were eighteen deaths. At least ten of these were due to chloroform, giving a mortality of one in 1,339 cases. This is still more striking when the fact is considered that these anæsthetics were all administered by experts. Such evidence would make one feel that chloroform in the hands of a novice is an extremely dangerous drug, and that this type of anæsthesia should be used but seldom, and then only by some one not only skilled in the administration of chloroform, but in noting the early signs of disaster.

The author describes several methods of chloroform administration in detail. The outstanding facts gleaned from this is that chloroform should be given very carefully, and that when the administration is once started it should not be withdrawn unless evidences of poisoning are manifest, or until the patient reaches surgical anæsthesia.

This little volume is indeed a very welcome addition to our literature, and for those men who still insist upon using chloroform as an anæsthetic, and who must of necessity have a considerable relative mortality, it is an invaluable contribution. J. A. W.

A SECOND edition of this volume[2] on wounds of the chest speaks for its authoritative popularity. In his introduction the author acknowledges the experience in these wounds gained during the world war and calls attention to their gravity inasmuch as the chest contains the organs so necessary for life. The succeeding chapters are well divided in subject, starting with a general discussion of wounds caused by different types of arms, then taking up chest wounds from both statistical and pathological standpoints. Non-penetrating and penetrating chest wounds of the pleura and lung are described in orderly sequence. Late complications and delayed symptoms are given much attention. Then follows an excellent chapter on wounds of the pericardium and heart. The last four chapters cover wounds of the great vessels, œsophagus, mediastinum, and complications involving the abdominal cavity. KELLOGG SPEED.

THIS small book,[3] 192 pages, covers briefly the use of local anæsthesia in orthopedics and the surgery of childhood. Choice of anæsthetic, indication and methods of use for the whole body are described. The illustrations are diagrammatic and are plainly of help. The volume is a plea for the use of novostasin in all surgery of childhood. KELLOGG SPEED.

[1] CHLOROFORM ANÆSTHESIA. By A. Goodman Levy, M.D., M.R.C.P. With Foreword by Arthur R. Cushny, M.D., LL.D., F.R.S. New York: William Wood & Co., 1922.

[2] FERITE DEL TORACE. By Dott. Prof. Felice Rossi. 2d. ed. Bologna: Licinio Cappelli, 1922.

[3] L' ANESTESIA LOCALE IN CHIRURGIA PEDIATRICA ED IN ORTOPEDIA. By Dr. Oreste Nuzzi. Bologna: Licinio Cappelli, 1922.

BOOKS RECEIVED

Books received are acknowledged in this department, and such acknowledgment must be regarded as a sufficient return for the courtesy of the sender. Selections will be made for review in the interests of our readers and as space permits.

NURSERY GUIDE FOR MOTHERS AND NURSES. By Louis W. Sauer, M.A., M.D. St. Louis: C. V. Mosby Company, 1923.

CHIRURGIE DU MEMBRE INFERIEUR. 5th ed. revised. By Georges Labey and Jacques Leveuf. Paris: Masson et Cie., 1923.

THE PATHOLOGICAL PHYSIOLOGY OF SURGICAL DISEASES. By Prof. Dr. Franz Rost. Authorized translation by Stanley P. Reimann, M.D. With a Foreword by John B. Deaver, M.D., LL.D., Sc.D., F.A.C.S. Philadelphia: P. Blakiston's Son & Company, 1923.

LEHRBUCH DER GEBURTSHILFE. By Prof. Dr. Rud. Th. v. Jaschke and Prof. Dr. O. Pankow. 2nd and 3rd ed. Berlin: Julius Springer, 1923.

TRANSACTIONS OF THE AMERICAN SURGICAL ASSOCIATION. Vol. xi. Edited by Dr. John H. Jopson, M.D. Philadelphia: William J. Dornan, 1922.

THE PATIENT'S VIEW POINT. By Dr. Paluel J. Flagg. Milwaukee: The Bruce Publishing Co., 1923.

LES TUMEURS DU CERVEAU. By C. E. Locke, Jr., M.D. Paris: Louis Arnette, 1922.

LA RADIOTHÉRAPIE PROFONDE. By Dr. Iser Solomon. Paris: Masson et Cie, 1923.

ENLARGEMENT OF THE PROSTATE. By John B. Deaver, M.D., LL.D., Sc.D., F.A.C.S. 2nd ed. Philadelphia: P. Blakiston's Son & Co., 1922.

THE SURGICAL DISEASES OF CHILDREN. By Frederick C. Pybus, M.S., F.R.C.S. Philadelphia: P. Blakiston's Son & Co., 1922.

DIE KNOCHENBRUECHE UND IHRE BEHANDLUNG. Ein Lehrbuch fuer Studierende und Aerzte. Vol. ii. By Dr. Med. Hermann Matti. Berlin: Julius Springer, 1922.

A MANUAL OF GYNECOLOGY. 2d ed. By John Osborn Polak, M.Sc., M.D., F.A.C.S. Philadelphia and New York: Lea & Febiger, 1922.

PREMATURE AND CONGENITALLY DISEASED INFANTS. By Julius H. Hess, M.D. Philadelphia and New York. Lea & Febiger, 1922.

THYROID and THYMUS. By André Crotti, M.D., F.A.C.S., LL.D. Philadelphia and New York: Lea & Febiger, 1922.

GETTING READY TO BE A MOTHER. A Little Book of Information and Advice for the Young Woman Who is Looking Forward to Motherhood. By Carolyn Conant Van Blarcom, R. N., with an introduction by J. Clifton Edgar, M.D., and Frederick W. Rice, M.D. New York: The Macmillan Company, 1922.

GENERAL AND PROFESSIONAL BIOLOGY WITH SPECIAL REFERENCE TO MAN. By Edward J. Menge, Ph.D. Milwaukee: The Bruce Publishing Company, 1922.

THE PRACTICE OF SURGERY. 3d ed. By Russell Howard, C.B.E., M.S. (Lond.), F.R.C.S. (Eng.). Philadelphia: J. B. Lippincott Company, 1922.

A MANUAL OF DISEASES OF THE NOSE AND THROAT. 6th ed. rev. By Cornelius G. Coakley, A.M., M.D., F.A.C.S. Philadelphia and New York: Lea & Febiger, 1922.

MINOR SURGERY INCLUDING BANDAGING. 9th ed. rev. By Henry R. Wharton, M.D. Philadelphia and New York: Lea & Febiger, 1922.

DISEASES OF THE EAR, NOSE AND THROAT; Medical and Surgical. 6th ed. rev. By Wendell Christopher Phillips, M.D. Philadelphia: F. A. Davis Company, 1922.

ORTHOPEDIC SURGERY. By Sir Robert Jones, K.B.E., C.B., and Robert W. Lovett, M.D., F.A.C.S. New York: William Wood and Company, 1923.

NUTRITION OF MOTHER AND CHILD. By C. Ulysses Moore, M.D., M.Sc. Philadelphia: J. B. Lippincott Company, 1923.

DIE PATHOLOGISCH-ANATOMISCHEN GRUNDLAGEN DER FRAUENKRANKHEITEN. By Prof. Dr. Wilhelm Lahm. Dresden and Leipzig: Theodor Steinkopff, 1923.

DIE BEHANDLUNG DER HAUT-UND GESCHLECHTSKRANKHEITEN MIT KURZER DIAGNOSTIK. By Dr. Erich Hoffmann. Bonn: A. Marcus & E. Webers, 1923.

A MANUAL OF SURGICAL ANATOMY. 2nd ed. By Lewis Beesly, F.R.C.S., (Edin.), and T. B. Johnston, M.D., Ch.B. New York: William Wood & Company, 1923.

ANÆSTHETICS AND THEIR ADMINISTRATION. 5th ed. By Sir Frederic W. Hewitt, M.V.O., M.A., M.D., edited by Henry Robinson, M.A., M.D., B.Ch. London and New York: Oxford University Press, 1922.

ESSENTIALS OF SURGERY; a Textbook of Surgery. 2d ed. rev. By Archibald Leete McDonald, M.D. Philadelphia and London: J. B. Lippincott Co., 1923.

HOW WE RESIST DISEASE. By Jean Broadhurst, Ph.D. Philadelphia and London: J. B. Lippincott Co., 1923.

OPTICAL METHODS IN CONTROL AND RESEARCH LABORATORIES. Vol. I (2d ed., January, 1923). By J. N. Goldsmith, Ph.D., M.Sc., F.I.C.; S. Judd Lewis, D.Sc., B.Sc., F.I.C., PhC., and F. Twyman, F. Inst. P. London: Adam Hilger, Ltd., 1923.

THE NEW PHYSIOLOGY IN SURGICAL AND GENERAL PRACTICE. 5th ed. rev. By A. Rendle Short, M.D., B.S. (Lond.), F.R.C.S. (Eng.) New York: William Wood & Co., 1922.

PRACTICAL ANÆSTHETICS; for the Student and General Practitioner. By Charles F. Hadfield, M.B.E., M.A., M.D. New York: William Wood & Co., 1923.

CHARLES WHITE OF MANCHESTER (1728–1813), and THE ARREST OF PUERPERAL FEVER. By J. George Adami, C.B.E., M.D., F.R.S. London: Hodder & Stoughton, Ltd., 1922.

ÉTUDE RADIOLOGIQUE DES VOIES BILIAIRES NORMALES ET LITHIASIQUES. By Pierre Duval, Gatellier and Henri Béclère. Paris: Masson et Cie, 1922.

MISTAKES AND ACCIDENTS OF SURGERY. By Harold Burrows, C.B.E., M.B., B.S.(Lond.), F.R.C.S. New York: William Wood & Co., 1923.

EINFUEHRUNG IN DIE KLINIK DER INNEREN SEKRETION. By Prof. Dr. G. Peritz. Berlin: S. Karger, 1923.

THE RIDDLE OF THE RHINE. Chemical Strategy in Peace and War. By Victor Lefebure. With a preface by Marshal Foch and an introduction by Field Marshal Sir Henry Wilson (Bart.), New York: E. P. Dutton & Company, 1923.

AMERICAN COLLEGE OF SURGEONS

THE LAYING OF THE CORNER STONE OF THE GORGAS MEMORIAL INSTITUTE OF TROPICAL MEDICINE[1]

By DR. BELISARIO PORRAS, Panama, Panama
President of the Republic of Panama

I experience profound satisfaction from the fact that it is my privilege to lay the corner stone of the Institute of Tropical Medicine which Panama dedicates to William Crawford Gorgas, to perpetuate his memory here, on the shores of the murmuring Pacific and in close proximity to that thoroughfare which—hurriedly in former days as though pursued by the phantom of death and lingeringly today as though regretting the brevity of time which compels them to forego the delights of our benign and even climate, the beauty of our country's unchanging verdure and the incomparable blue of our sky—has been used by men of every nationality for whom Gorgas cherished only sentiments of deep humanity which prevailed always over every prejudice of race, nationality, birth, or class.

This sense of satisfaction that I experience now is derived primarily from the fact that I was a friend of this man to whose memory we are today assembled here to pay tribute, and as such, I was in an admirable position to judge fully the purity of his noble and good heart, and, further, being one of the old men of the days when he lived in our midst, I am better able to appreciate more fully than the men of the younger generation, the great work of health, life, and happiness which this great man accomplished for my country.

The monument which we will erect here will be an expression of Panama's gratitude to the man who proved beyond the peradventure of a doubt that the tropics could be made habitable for all the races of the earth. We are indebted to the genius of Gorgas for the transformation of Panama from a fever-ridden land to the paradise we now live in. Therefore, we consider that Gorgas to a certain extent belongs to us also, because it was here he saw his great effort to lighten the burden of suffering humanity, crowned with success.

It is the privilege of great men, sages, discoverers, heroes and martyrs, whose activities, teachings, and examples are not circumscribed to the narrow confines of the land of their birth and whose achievements in the world have been beneficial to the majority if not to all their fellow-beings, to be universally loved. Such men—and Gorgas was one of them—cannot be citizens of one particular city, town, or village, for every city and every nation of the earth claims them; they are the real citizens of the world.

As in the case of Æsculapius, when it was found necessary to enlist the services of an oracle to determine in which of the cities of ancient Greece which disputed this honor, was his birthplace, and, as in the case of Christopher Columbus, who has been declared an Italian, a Spaniard and more recently a Jew, the birthplace of Gorgas, I am informed, is disputed, both Alabama and Georgia claiming this honor. However, Gorgas does not belong exclusively to the United States of North America where he was educated. Cuba and Serbia, Bulgaria and Ecuador, Panama and South Africa, all have claims to him as a result of his having lived and worked among them for the good of the human family.

The work accomplished in the world by the great Gorgas is immense, immeasurable. Of Hippocrates it may be said that he was the first to divorce medicine from witchcraft and the ecclesiastical mysticism of his times; of Galen, that he was a great physician and writer to whom is attributed the authorship of about 500 books intended to popularize the practice of medicine; of the great Pasteur, de Kock, Ramon Cajal y Cajal, Elhricj, Finley and Rose, that they penetrated far into the hidden secrets of the invisible, the infinitesimal world; of Metchnikoff that he evolved the famous phagocyte theory and with Roux, Chamberland, and Calmette, collaborated in and continued the work of the great Pasteur; but how can we describe Gorgas, who solved the apparently impossible problem of making the tropics habitable, thus complementing the marvellous work of God Who created us in order that we might live on this terrestrial globe and be happy on it? Gorgas destroyed the morasses of

[1]Address delivered at the laying of the corner stone of the Institute, February 18, 1923, at Panama, Panama.

death and gave us pure drinking water and purified the air of our exuberant tropical forests and our colonial cities. Gorgas redeemed the tropics.

I can still remember, and it seems to me a horrible nightmare, the time, 50 years ago when, on my way to Bogota to finish my studies I found it necessary to spend a night in Colon. Sleep during that night was impossible for me because of the constant and tormenting bites of the mosquitoes, the incessant buzzing of which smote on my ears as though they were the discordant notes of an infernal serenade. These minute tormentors were so numerous that by clutching at the apparently empty air I caught handful after handful of these tormenting pests. Neither can I forget conditions as they prevailed when I returned from college ten years later and entered the employ of the French Canal Company. From that time I was able to realize or at least suspect the underlying cause of the Frenchmen's failure in their attempt to construct the trans-Isthmian waterway. They constructed beautiful residences and tree-lined avenues and admirably organized their offices; but they did nothing, in fact they knew nothing, about tropical sanitation and apparently never suspected its worth.

In those days of long-ago, it was the most natural thing for one to promenade the city's thoroughfares holding a handkerchief to one's nostrils, to keep out or lessen the stench contaminating the air as a result of decaying vegetation, stagnant or putrid puddles and primitive or defective sewerage. On every hand one encountered well-beloved friends hastening home in the grip of malarial chills or some other equally pernicious fever; or encountered on every street, people clothed in the somber black garb of mourning with the marks of grief and despair deeply impressed on their features; or daily heard the lugubrious tolling of church bells announcing the death of a friend or a relative; or was frequently summoned to attend the last rites of a departed friend laid low by the deadly miasmas of our unsanitary tropical homeland.

However, thanks to William Crawford Gorgas, these days have passed never to return and our tropical home has become one of the world's health resorts.

In the days of ancient Greece, shrines and temples were erected in the mountains and at the Springs of Health in honor of Æsculapius, the God of Medicine. To these places of worship and thanksgiving an endless stream of sick and afflicted persons came to offer sacrifices and deposit votive tablets on his altars. And it is a temple such as these that we will erect here as a living testimonial to the memory of the man who brought so much comfort to the Isthmian family and the tropical world in general.

On this first stone, there will arise a great temple dedicated to this great man, and to this shrine of Gorgas will come in a never-ceasing pilgrimage, not only our sick compatriots but also the afflicted thousands from other points of the tropics to seek health with undying faith in the name of Gorgas. And they will depart hence for their distant homes, healed and happy, with tears of gratitude in their eyes and blessing our beloved country and the great and humane work of William Crawford Gorgas, the benefactor of humanity and the redeemer of the Tropical World.

THE PURPOSE OF THE INSTITUTE

By AUGUSTO S. BOYD, M.D., F.A.C.S. (Hon.), Panama, Panama

THE medical body of Panama accompanied by a select delegation of the most eminent surgeons of the United States of North America, are assembled today to witness the founding of a temple of science, in which will gather the men of science from all the races of the world to work in unison and for the sole purpose of finding relief for humanity's ills through the eradication of the many diseases which afflict mankind.

Nothing more logical than that Panama, filled with gratitude for the immense services rendered her children by that illustrious North American, William Crawford Gorgas—on initiating and carrying out the establishment here of an Institute for Research in tropical diseases—should have selected his name as the most fitting by which this institute should be known; because, the transformation recorded in the salubrity of our country and the happy termination of that great undertaking *pro mundi beneficio* are worthy fruits of his admirable application of the principles of modern hygiene, which though already known, required for their successful application a great organizing head extremely careful of details.

Therefore, our chief executive, His Excellency President Belisario Porras, on suggesting the creation in our country of an institute similar to

the Rockefeller Foundation, with altruistic aims and for the benefit not only of the Americans but of the entire tropical world, happily decided that said institute should bear the name of the famous hygienist and benefactor of Panama, and this suggestion was well received everywhere and the project is now a fact with the by-laws of the institution duly registered in the State of Delaware of the United States of North America and here in our country.

The Gorgas Institute is presided over by a Board of Directors of which Rear Admiral William C. Braisted is the head, and a board of scientific directors over which presides a no less illustrious personage, Dr. Richard P. Strong. The collaborators in the practical and theoretical work of the institute will be selected from among the most important international schools and institutions in France, Great Britain, Japan, the United States and South America. This institution will also open a greater field to our doctors, where, on proving its competency and passing the required test, the merits of the Panamanian brain may victoriously conquer the laurels of the savant, offer to humanity the fruits of its efforts and add to the luster of the nation's good name, as is the duty of every good citizen. And I take advantage of this opportunity to urge you all, especially those of the younger generation which is now coming up, to undertake the study of our science with all your might and determination, undergoing all the sacrifices demanded by work of this nature, confident that when you have reached the goal you will be amply compensated with the eternal gratitude of your countrymen and that of the entire world.

As an example of this, I may cite the career of the eminent American hygienist, very worthy of emulation, to whom we are paying tribute today, perpetuating his memory with the dedication of an institute which will bear his name, a name which will ever be heard with the respectful veneration as is its due.

Many of those gathered here today are aware of the arduous struggles which attended the early attempts of the disciples of the great de Lesseps, whose collaborators were decimated by the cruel diseases of that time against which medical science made heroic but useless efforts, as occurs when unknown obstacles are encountered. Of 100,000 men who worked in the excavation of the Canal during a period of nine years, the death rate reached the enormous total of 22,000 men. Malaria placed its deadly touch on the most beloved members of our families—the bloodless, apathethic and exhausted semblances of our dear brothers and children who entered the zones of labor to return home sick and disheartened, some of them only to breathe their last in the midst of their loved ones, is so recent an experience that it must undoubtedly be still fresh in our memories. Our tender babes succumbed quickest to attacks of the pernicious fever in those days when physicians had to travel around with the hypodermic ready to administer the quinine injection.

With what pride and what satisfaction we can say today: "All this has disappeared now!" And to whom do we owe this?

To that illustrious and good friend, the indefatigable Gorgas.

Intimately connected with the Gorgas Institute will be our new Santo Thomas Hospital. Once again we of the medical profession must voice our gratitude to the progressive citizen who directs the destinies of our Republic. His Excellency Dr. Belisario Porras, in his efforts to equip the Republic with a hospital for his fellow citizens, modern in architecture and in equipment, has considered nothing too good for the relief of his afflicted countrymen, regardless of creed or color.

The expense which the construction of this new hospital entails for our treasury can never be considered excessive if we take into account the fact that it is for us all and for our posterity. I feel safe in asserting that our work will be at least twenty per cent more efficient than it is at present, once we begin working under these new conditions. What today might seem to the uninitiated a needless luxury, will later on be regarded as a godsend, a blessing.

Modern hospitals which are equipped with all the advantages which hygiene and science offer have, as their fundamental basis, microscopic cleanliness and other details of ventilation, lighting and sewerage which are costly in their installation, especially as regards operation rooms and maternity wards, which must be free of every element which might make infections possible.

I, as a physician, and you as the parties benefited in your health, can do nothing less than applaud the undertaking and support it in order to accelerate its early termination and be able to enjoy its benefits at the earliest possible moment.

In conclusion you will permit me to voice our welcome and gratitude to our visitors, my honorable colleagues, for their participation with us in these ceremonies.

Fellow colleagues of the American College of Surgeons:—In behalf of the Government, the people and the medical profession of Panama, let me welcome you to our midst, thanking you

for honoring with your presence our festivities of the day, inaugurating the work of construction of the Gorgas Memorial Institute.

The name of Gorgas is cherished by all Panamanians as that of a public benefactor, and as a means of showing our gratitude for the great work he has accomplished in our midst, we have honored our future Institute of Research by giving it his name as he must live in our history side by side with our great men.

After terminating your trip to the southern sister republics, where we are sure you will find a no less hearty welcome than in Panama, and when you are once again in your respective homes, we hope that you will bring to mind fond recollections of this day and do what your weighty prestige can toward favoring this work, so that the Institute will have the character and scope hoped for.

Wishing you *bon voyage*, we would like to impress upon you that our medical institutions, present and future, are open to you all; here you will be gladly welcomed and the co-operation of your wisdom invited and highly appreciated.

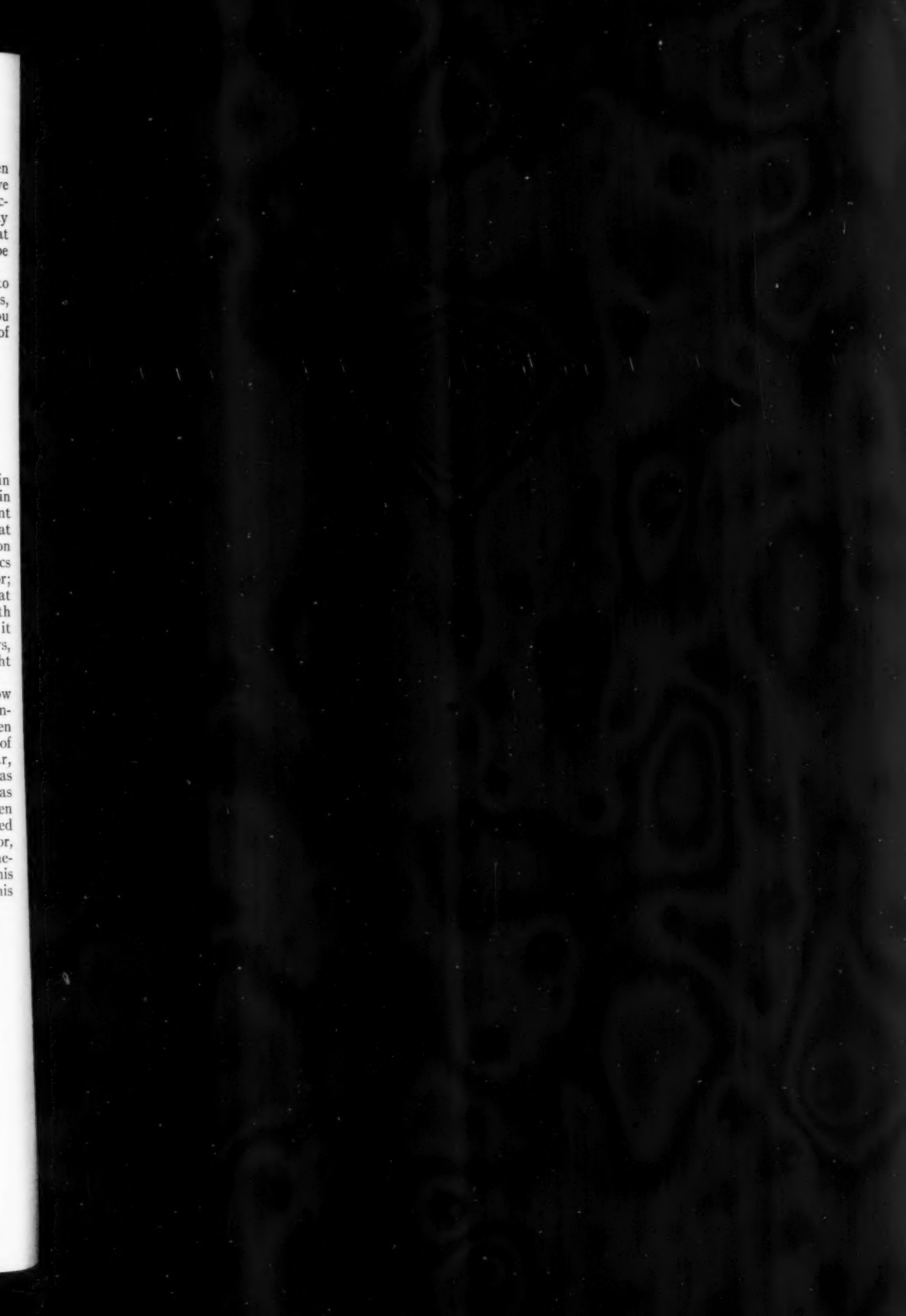
RESPONSE TO TRIBUTE TO GORGAS

By FRANKLIN H. MARTIN, M.D., Chicago
Acting President, Gorgas Memorial Institute for Tropical and Preventive Medicine; Director-General, American College of Surgeons

IT is fitting that we, surgeons from Canada and from the United States, many of whom served in the uniform of our chief, traveling to pay our respects to the Central and South American countries, should assemble with our families and yours in this garden paradise to honor the memory of William Crawford Gorgas, whose genius brought to it its worth, its beauty, and its charm.

Gorgas, simple in character, a lover of men, with a vision of the fundamentals of the intricate discoveries of science, by the simple application of a formula conceived by him, wrought a miracle that for all time will enrich the world, as Lister revolutionized surgical progress from the discoveries of Pasteur, and as the lowly Nazarene brought forth from the wisdom of the prophets his pronouncement that Christianized the world.

We, assembled here, are the apostles of Gorgas, brought together by our mutual admiration for him, to build on this place a monument that will be to us and to all people a symbol of his greatness, and that will enable his devoted followers to continue his work as he himself would have desired. It cannot add one iota to the monument that he created in his modest way, by his honest character, his gentle persistency, his unostentatious industry, and his enduring patience.

For, in one century, in ten centuries, or in twenty centuries it will be known that it was in this little country, between two seas, that he went about and did his work, and citizens of great commonwealths of the future, on the Orinoco, on the Amazon, on the Ganges, and in all the tropics of the earth will tell how Gorgas was their savior; how he brought to them a physical blessing that transformed their regions from the lands of death to the living communities of civilization; and it will be remembered then, in those far off days, that we, his contemporaries, loved him and sought to honor him.

President Porras, you know, and I know, how our friend loved this, his beloved isthmian country, and how, in the evening of his life, when upon him rested the enormous responsibility of presiding over a great corps of the greatest war, in his moments of contemplation, his vision was turned toward Panama, the place which was selected by him to be his final earthly home when retirement should come. And we, here gathered to pay tribute to him, the great benefactor, may be assured, if the screen is not too impenetrable, that around us, in approbation, is his genial presence in spirit, and over us is shed his love and his benediction.